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THE SEXUAL BRAIN

WHAT REALLY GOES ON IN THERE

WHY KISSING IS A TURN-ON

A SURPRISING KEY TO ORGASM

THE SUNNY SIDE OF SMUT

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YOUR THREE-POUND SEX ORGAN

Hollywood movies would have you believe that you can have sex without taking the time to remove your underwear (or wetsuit). You can also make love effortlessly in a standing position, with both of you climaxing quickly—simultaneously, of course, and while making attractive sounds and facial expressions. At the other extreme is modern pornography, in which coupling (if I may use that word to refer to activities that often involve a roomful of people) is fantastically prolonged and explicit.

What really goes on in the bedroom? Perhaps the cameras should be trained on the largest and most important sex organ, the brain. That's where physical and psychological stimuli get translated into signals important to arousal and orgasm, a process that brain imaging is beginning to reveal, as described in "The Orgasmic Mind" (*page 4*) and "Lust's Reward" (*page 14*). Humans might even have a nerve in the head that detects erotic chemical messages ("Sex and the Secret Nerve," *page 34*).

The brain plays a critical role in our response to locking lips and in sexual dysfunction, explored in articles about the act of kissing ("Affairs of the Lips," *page 18*) and a surprisingly miserable affliction ("When Arousal Is Agony," *page 26*). This special edition also reveals what neuroscientists and psychologists have to say about bisexuality, sexual preferences and gender identity in articles such as "Bisexual Species" (*page 50*), "Do Gays Have a Choice?" (*page 56*), "The Truth about Boys and Girls" (*page 64*) and "Transgender Kids" (*page 72*).

Science is struggling to catch up with radical transformations in attitudes toward love and sex: In the U.S., the majority of adults now see nothing wrong with premarital intercourse. Sex between people of the same gender has become widely accepted, and gay marriage is legal. Consideration for the rights of transgender people is growing. Pornography is readily available online and heavily consumed, though rarely discussed. (The good news is that it's harmless to most people, as "The Sunny Side of Smut" explains on page 24.) The Internet has also become a popular hangout for people seeking partners, and the rise of mobile dating has made hookups easier than ever, as the authors of "Dating in a Digital World" (*page 104*) lay out in their guide to online dating.

Some things haven't changed, though, as "Lust for Life" (*page 10*) and "The Happy Couple" (*page 86*), respectively, suggest: pure sexual desire and a focus on positive emotions make for happily-ever-after relationships. If not good movies.

Dawn Stover
Issue Editor
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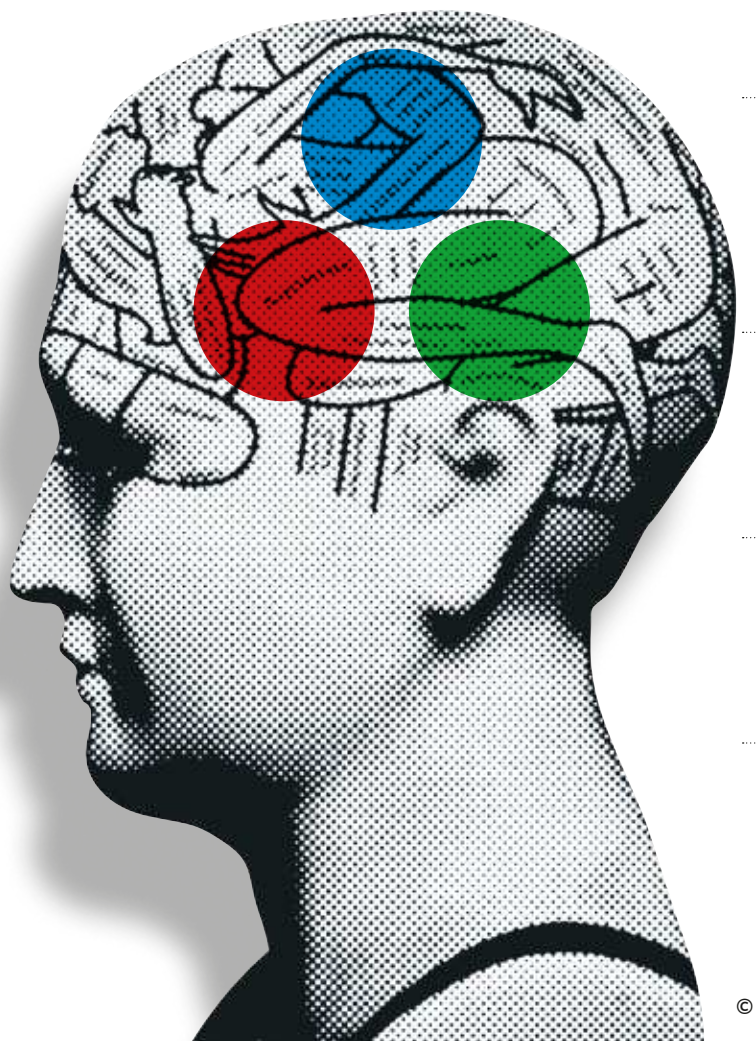

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THE SEXUAL BRAIN

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LUST

THE ORGASMIC MIND

BY Martin Portner

Achieving sexual climax requires a complex conspiracy of sensory and psychological signals—and the eventual silencing of critical brain areas

PETE TURNER Getty Images (*silhouette of head*); GETTY IMAGES (*fireworks*)

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SHE DID NOT OFTEN HAVE SUCH STRONG EMOTIONS. BUT SHE SUDDENLY FELT POWERLESS AGAINST HER PASSION AND THE DESIRE TO THROW HERSELF INTO THE ARMS OF THE COUSIN WHOM SHE SAW AT A FAMILY FUNERAL.

"It can only be because of that patch," said Gretchen (not her real name), a participant in a multinational trial of a testosterone patch designed to treat hypoactive sexual desire disorder, in which a woman is devoid of libido. Testosterone, a hormone ordinarily produced in women by the ovaries, is linked to female sexual function, and the women in this 2005 study had undergone operations to remove their ovaries.

After 12 weeks of the trial, Gretchen had felt her sexual desire return. Touching herself unleashed erotic sensations and vivid sexual fantasies. Eventually she could make love to her husband again and experienced an orgasm for the first time in almost three years. But that was not because of testosterone, it turned out. Gretchen was among the half of the women who had received a placebo patch—with no testosterone in it at all.

Gretchen's experience underlines the complexity of sexual arousal. Far from being a simple issue of hormones, sexual desire and orgasm are subject to various influences on the brain and nervous system, which controls the sex glands and genitals. And many of those influences are environmental. Recent research, for example, shows that visual stimuli spur sexual stirrings in women, as they do in men. Gretchen's desire may have been invigorated by conversations or thoughts about sex she had as a result of taking part in the trial. Such stimuli may help relieve inhibitions or simply whet a person's appetite for sex.

Achieving orgasm, brain-imaging studies show, involves more than heightened arousal. It requires a release of inhibitions and control in which the brain's center of vigilance shuts down in males; in females, various areas of the brain involved in controlling thoughts and emotions become silent. The brain's pleasure centers tend to light up brightly in the brain scans of both sexes, especially in those of males. The reward system creates an incentive to seek more sexual encounters, with clear benefits for the survival of the species. When the drive for sex dissipates, people can reignite the spark with tactics that target the mind.

Biologist Alfred Kinsey shocked the public more than half a century ago with his revelations about human sexual behavior.

Sex in Circles

Biologists identified sex hormones such as estrogen and testosterone in the 1920s and 1930s, and the first studies of human sexuality appeared in the 1940s. In 1948 biologist Alfred Kinsey of Indiana University introduced his first report on human sexual practices, *Sexual Behavior in the Human Male,* which was followed, in 1953, by *Sexual Behavior in the Human Female*. These books not only broached topics—such as masturbation, homosexuality and orgasm—that many people considered taboo but also revealed the surprising frequency with which people were coupling and engaging in sexual relations of countless varieties.

Kinsey thus debuted sex as a science, paving the way for others to dig below statistics into the realm of biology. In 1966 gynecologist William Masters and psychologist Virginia Johnson—who founded their own research institute in St. Louis—described for the first time the sexual response cycle (how the body responds to sexual stimulation), based on observations of 382 women and 312 men undergoing some 10,000 such cycles. The cycle begins with excitation, as blood rushes to the penis in men, and as the clitoris, vulva and vagina enlarge and grow moist in women. Gradually, people reach a plateau, in which they are fully aroused but not yet at orgasm. After orgasm, they enter the resolution phase, in which the tissues return to the preexcitation stage.

In the 1970s psychiatrist Helen Singer Kaplan of the Human Sexuality Program at Weill Medical College of Cornell University added a critical element to this cycle—desire—based on her experience as a sex therapist. In her three-stage model, desire precedes sexual excitation, which is then followed by orgasm. Because desire is mainly psychological, Kaplan emphasized the importance of the mind in the sexual experience and the destructive forces of anxiety, de-

FAST FACTS
PRINCIPLES OF PLEASURE

1. Sexual desire and orgasm are subject to various influences on the brain and nervous system, which controls the sex glands and genitals.
2. The ingredients of desire may differ for men and women, but researchers have revealed some surprising similarities. For example, visual stimuli spur sexual stirrings in women, as they do in men.
3. Achieving orgasm, brain-imaging studies show, involves more than heightened arousal. It requires a release of inhibitions engineered by shutdown of the brain's center of vigilance in both sexes and a widespread neural power failure in females.

GETTY IMAGES

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Like men, women can be aroused by visual stimuli.

fensiveness and failure of communication.

In the late 1980s gynecologist Rosemary Basson of the University of British Columbia proposed a more circular sexual cycle, which, despite the term, had been described as a largely linear progression in previous work. Basson suggested that desire might both lead to genital stimulation and be invigorated by it. Countering the idea that orgasm is the pinnacle of the experience, she placed it as a mere spot on the circle, asserting that a person could feel sexually satisfied at any of the stages leading up to an orgasm.

Dissecting Desire

Given the importance of desire, researchers have long wanted to identify its key ingredients. Conventional wisdom casts the male triggers in simplistic sensory terms, with tactile and visual stimuli being particularly enticing. Men are drawn to visual erotica; female desire is supposedly fueled by a richer cognitive and emotional texture. "Women experience desire as a result of the context in which they are inserted—whether they feel comfortable with themselves and the partner, feel safe and perceive a true bond," opines urologist Jennifer Berman, former director of the Female Sexual Medicine Center at the University of California, Los Angeles.

Yet sexual imagery devoid of emotional connections can arouse women just as it can men, a 2007 study shows. Psychologist Meredith Chivers, then at the Center for Addiction and Mental Health in Toronto, and her colleagues gauged the degree of sexual arousal in about 100 women and men, both homosexual and heterosexual, while they watched film clips depicting same-sex intercourse, solitary masturbation or nude exercise—performed by men and women—as well as male-female intercourse and mating between bonobos (ape relatives of the chimpanzee).

Simple sensations and more complex mental processes probably contribute to orgasm in both sexes.

The researchers found that although nude exercise genitally aroused all the onlookers the least and intercourse excited them the most, the type of actor was more important for the men than for the women. Heterosexual women's level of arousal increased along with the intensity of the sexual activity largely irrespective of who or what was engaged in it. In fact, these women were genitally excited by male and female actors equally and also responded physically to bonobo copulation. (Gay women, however, did not react sexually to men masturbating or exercising naked.)

The men, in contrast, were physically titillated mainly by their preferred category of sexual partner—that is, females for straight men and males for gay men—and were not excited by bonobo copulation. The results, the researchers say, suggest that women are not only aroused by a variety of types of sexual imagery but are more flexible than men in their sexual interests and preferences.

Leah Millheiser of Stanford University and her colleagues added another piece to this complex puzzle in 2009. Using functional MRI scans, they saw activation of a small area in the temporal lobe of the brain while one group of women viewed erotic material. This brain area, the entorhinal cortex, was significantly less activated in women with low libido than in women with normal sex drives. The entorhinal cortex is involved in forming and retrieving positive emotional memories, which suggests that women with low desire may be unable to use memories from previous sexual experiences as motivation to initiate or enjoy new sexual experiences. Sex, desire and possibly orgasm may create a mental staircase in which every new encounter is built on pleasurable memories.

When it comes to orgasm, simple sensations as well as higher-level mental processes probably also play a role in both sexes. Although Kinsey characterized orgasm in purely physical terms, psychologist Barry R. Komisaruk of Rutgers University has defined

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the experience as more multifaceted. In their book *The Science of Orgasm* (Johns Hopkins University Press, 2006), Komisaruk, the late endocrinologist Carlos Beyer-Flores of the Tlaxcala Laboratory in Mexico and Rutgers sexologist Beverly Whipple describe orgasm as maximal excitation generated by a gradual summing of responses from the body's sensory receptors, combined with complex cognitive and emotional forces. Similarly, psychologist Kent Berridge of the University of Michigan has described sexual pleasure as a kind of "gloss" that the brain's emotional hub, the limbic system, applies over the primary sensations.

The relative weights of sensory and emotional influences on orgasm may differ between the sexes, perhaps because of its diverging evolutionary origins. Orgasm in men is directly tied to reproduction through ejaculation, whereas female orgasm has a less obvious role. Orgasm in a woman might physically aid in the retention of sperm, or it may play a subtler social function, such as facilitating bonding with her mate. If female orgasm evolved primarily for social reasons, it might elicit more complex thoughts and feelings in women than it does in men.

Forgetting Fear

But does it? Researchers are trying to crack this riddle by probing changes in brain activity during orgasm in both men and women. Neuroscientist Gert Holstege of the University of Groningen in the Netherlands and his colleagues attempted to solve the male side of the equation by asking the female partners of 11 men to stimulate their partner's penis until he ejaculated while they scanned his brain using positron-emission tomography (PET). During ejaculation, the researchers saw extraordinary activation of the ventral tegmental area, a major hub of the brain's reward circuitry; the intensity of this response is comparable to that induced by heroin. "Because ejaculation introduces sperm into the female reproductive tract, it would be critical for reproduction of the species to favor ejaculation as a most rewarding behavior," the researchers wrote in 2003 in the *Journal of Neuroscience*.

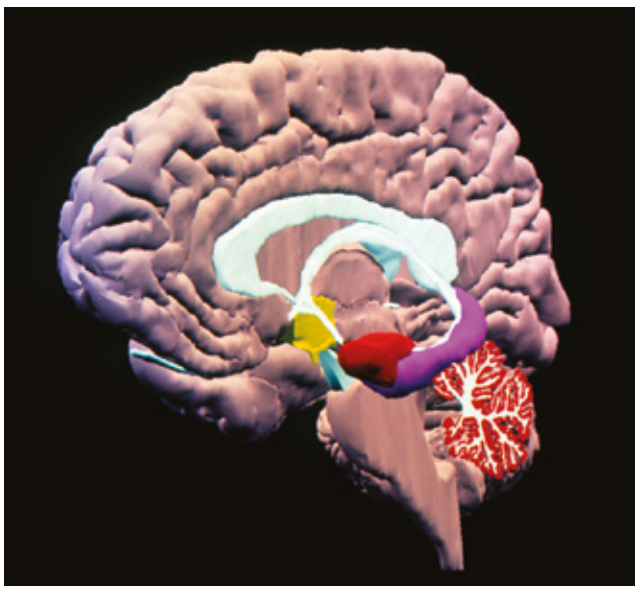
When a woman reached orgasm, something unexpected happened: much of her brain went silent.

The scientists also saw heightened activity in brain regions involved in memory-related imagery and in vision itself, perhaps because the volunteers used visual imagery to hasten orgasm. The anterior part of the cerebellum also switched into high gear. The cerebellum has long been labeled the coordinator of motor behaviors but has more recently revealed its role in emotional processing. Thus, the cerebellum could be the seat of the emotional components of orgasm in men, perhaps helping to coordinate those emotions with planned behaviors. The amygdala, the brain's center of vigilance and sometimes fear, showed a decline in activity at ejaculation.

To find out whether orgasm looks similar in the female brain, Holstege's team asked the male partners of 12 women to stimulate their partner's clitoris—the site whose excitation most easily leads to orgasm—until she climaxed, again inside a PET scanner. Not surprisingly, the team reported in 2006, clitoral stimulation by itself led to activation in areas of the brain involved in receiving and perceiving sensory signals from that part of the body and in describing a body sensation—for instance, labeling it "sexual."

But when a woman reached orgasm, something unexpected happened: much of her brain went silent. Some of the most muted neurons sat in the left lateral orbitofrontal cortex, which may govern self-control over basic desires such as sex. Decreased activity there, the researchers suggest, might correspond to a release of tension and inhibition. The scientists also saw a dip in excitation in the dorsomedial prefrontal cortex, which has an apparent role in moral reasoning and social judgment—a change that may be tied to a suspension of judgment and reflection.

Brain activity fell in the amygdala, too, suggesting a reduction of vigilance similar to that seen in men, who generally showed far less deactivation in their brain during orgasm than their female counterparts did. "Fear and



During ejaculation, neural activity declines in the amygdala (*red region*), the brain's seat of vigilance—an apparent sign that men are momentarily throwing caution to the wind. In females, various regions of the brain, including the amygdala, virtually shut down at orgasm.

HANK MORGAN *Science Source*

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DOMESTIC BLISS

Is the pursuit of sexual gratification vital to the health of an established relationship?

In her book *Mating in Captivity* (HarperCollins, 2006), New York–based psychotherapist Esther Perel emphasizes the importance of eroticism and orgasm in a marriage. She chronicles the typical dissolution of a couple's sex life when the love bond becomes politically correct and excessively domesticated.

To avoid sexual staleness, Perel advocates unusual strategies such as cultivating separateness—developing different interests and groups of friends from those of your partner, for example—instead of closeness, as a way of making your partner more mysterious and exciting. She also suggests looking for creative ways to let fantasy and even a little craziness thrive within the confines of a long-term relationship.

Other psychologists, however, advise against placing too much emphasis on orgasm in a mature relationship. In her book *Peace between the Sheets* (Frog Books, 2003), couples therapist Marnia Robinson suggests that the journey to orgasm renders us prisoners to dopamine, a neurotransmitter secreted in the brain's reward centers. After all, dopamine underlies other addictive behaviors, from gambling to drug abuse. In Robinson's view, partners should mutually unite in pleasure, without the sexual relationship necessarily having to be crowned by orgasm. —*M.P.*

anxiety need to be avoided at all costs if a woman wishes to have an orgasm," Holstege says. He went so far as to declare at the 2005 meeting of the European Society for Human Reproduction and Development: "At the moment of orgasm, women do not have any emotional feelings."

But that lack of emotion may not apply to all orgasms in women. Komisaruk, Whipple and their colleagues studied the patterns of brain activation that occur during orgasm in five women with spinal cord injuries that left them without sensation in their lower extremities. These women were able to achieve a "deep," or nonclitoral, orgasm through mechanical stimulation (using a laboratory device) of the vagina and cervix. But contrary to Holstege's results, Komisaruk's team found that orgasm was accompanied by a general activation of the limbic system.

Among the activated limbic regions were the amygdala and the hypothalamus, which produces oxytocin, the putative love and bonding hormone whose levels jump fourfold at orgasm. The researchers also found heightened activity in the nucleus accumbens, a critical part of the brain's reward circuitry that may mediate orgasmic pleasure in women. In addition, they saw unusual activity in the anterior cingulate cortex and the insula, two brain areas that Rutgers anthropologist Helen Fisher has found come to life during the later stages of love relationships.

Pleasure Pill?

Disentangling the connections among orgasm, reproduction and love may someday yield better medications and psychotherapies for sexual problems. As Gretchen's case illustrates, the answer is usually not as simple as a hormone boost. Instead her improvement was probably the result of the activation or inactivation of parts of her brain by social triggers. Indeed, many sex therapies revolve around opening the mind to new ways of thinking about sex or about your partner [*see box at left*].

Companies are also working on medications that act on the nervous system, especially those capable of stimulating desire in women. Palatin Technologies in Cranbury, N.J., is developing bremelanotide, a drug that blocks certain receptors in the brain that are involved in regulating basic drives such as eating and sex. In human studies, it has produced spontaneous erections in men and boosted sexual arousal and desire in women. The FDA has raised concerns over side effects such as increased blood pressure, though, and the drug is still in clinical trials.

At the Netherlands-based biotech firm Emotional Brain, researchers are developing two drug candidates for women with sexual dysfunction. Lybrido is a combination of testosterone and sildenafil, the active ingredient in Viagra; Lybridos combines testosterone with buspirone, an anxiety medication.

In August 2015 the FDA approved the drug Addyi (flibanserin) to treat low sexual desire in premenopausal women, but so far it has not been as trailblazing as Viagra was for men. Continued scientific dissection of the experience of orgasm will likely lead to new pharmaceutical and psychological avenues for enhancing the sexual experience. Science has made much progress in understanding the orgasmic mind, but orgasm is more about joy than about technology. Overanalyzing this moment of intense pleasure may put a damper on the fun. M

MORE TO EXPLORE

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LUST FOR LIFE

LUST | THE SEXUAL BRAIN

BY Stephanie Cacioppo

AND John T. Cacioppo

ILLUSTRATIONS BY Eddie Guy

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Neuroscientists are learning how pure sexual desire contributes to lasting relationships

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PEOPLE OFTEN THINK OF LOVE AND LUST AS POLAR OPPOSITES—

love exalted as the binder of two souls, lust the transient devil on our shoulders, disturbing and disruptive. Now neuroscientists are discovering that lust and love work together more closely than we think. Indeed, the strongest relationships have elements of both.

The bifurcated treatment of love and lust dates to antiquity. The study of love as an academic subject is nearly a century old, with the sentiment covered in introductory textbooks of social psychology. Psychologists, primatologists, neuroanatomists and neurophysiologists came to see love—defined as an intense and complex feeling of deep affection—as responsible for long-term coupling and close relationships. The first psychological tools for measuring love appeared in the 1940s. In a review of the literature published in 2011, psychologist Elaine Hatfield and her colleagues at the University of Hawaii at Manoa identified 33 scales for measuring love's gradations.

In contrast, researchers have traditionally regarded lust as little more than uncontrolled sexual urges. The scientific study of lust remained verboten or limited to clinicians, psychiatrists and sex therapists dealing with social and behavioral problems. When the topic of lust did appear in the scientific literature, it was cast as an archaic emotion, a sinful feeling that needed to be suppressed or denied lest it challenge societal order, or an addiction that hijacked human thought, emotion and behavior in insidious ways.

Now, though, neuroimaging investigations are beginning to flesh out the relationship between lust and love. Some research does support the Jekyll and Hyde dichotomy. Studies have revealed that lust and love both have unique brain signatures, suggesting they are separable, with the brain able to generate lust in the absence of love and vice versa. In one study of 500 individuals conducted in the mid-1960s by psychologist Dorothy Tennov of the University of Bridgeport, 53 percent of the women and 79 percent of the men agreed with the statement "I have been sexually attracted without feeling the slightest trace of love"; 61 percent of the women and 35 percent of the men agreed with the statement "I have been in love without feeling any need for sex." Neuroimaging studies have also shown considerable overlap between the network for lust and the network underlying addiction, suggesting that the craving associated with lust brings with it impulsivity, lack of self-control and risk taking.

Other studies reveal a more complex and synergistic connection between lust and love. Both feelings can activate regions in the brain related to emotions, including euphoria, reward, motivation, addiction and body image. What is more, lust and love activate different parts of the same brain structures, the insula and the striatum.

A recent meta-analysis that we conducted of 20 studies with a total of 429 participants revealed that the posterior region of the insula activates more for lust than love, and the anterior region of the insula activates more for love than lust. This back-to-front distinction is in line with a broader principle of brain organization: posterior regions are involved in current, concrete sensations, feelings and responses, and anterior regions are involved in the integration of abstract concepts ranging from the distant past to alternative futures. In this model, lust would be grounded in particular sensory and motor experiences, with love as a more abstract, future-oriented gloss on those experiences with another person.

Studies show that as lust progresses

FAST FACTS
DECODING DESIRE

1. Brain imaging is revealing the distinct but interlocking patterns of neural activation associated with lust and love.
2. Lust is most likely grounded in the concrete sensations of the given moment. Love is a more abstract gloss on our experiences with another person.
3. Imaging is also helping to decipher the disorders of lust, including anorgasmia. Dozens of discrete regions across the brain fire at the point of orgasm—suggesting many different ways to develop anorgasmia.

THE AUTHORS

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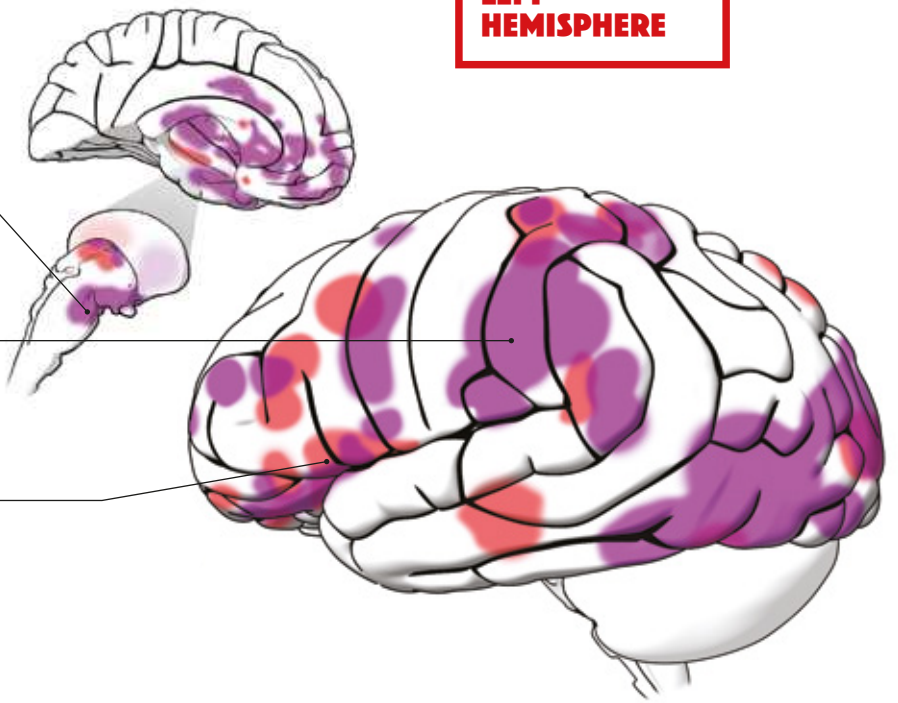
THE BRAIN IN LOVE (AND LUST)

The color hues in the "heat maps" show brain networks related to lust (*purple*) and love (*red*). Although numerous distinct brain regions contribute to our experience of love and lust, a few regions are particularly significant.

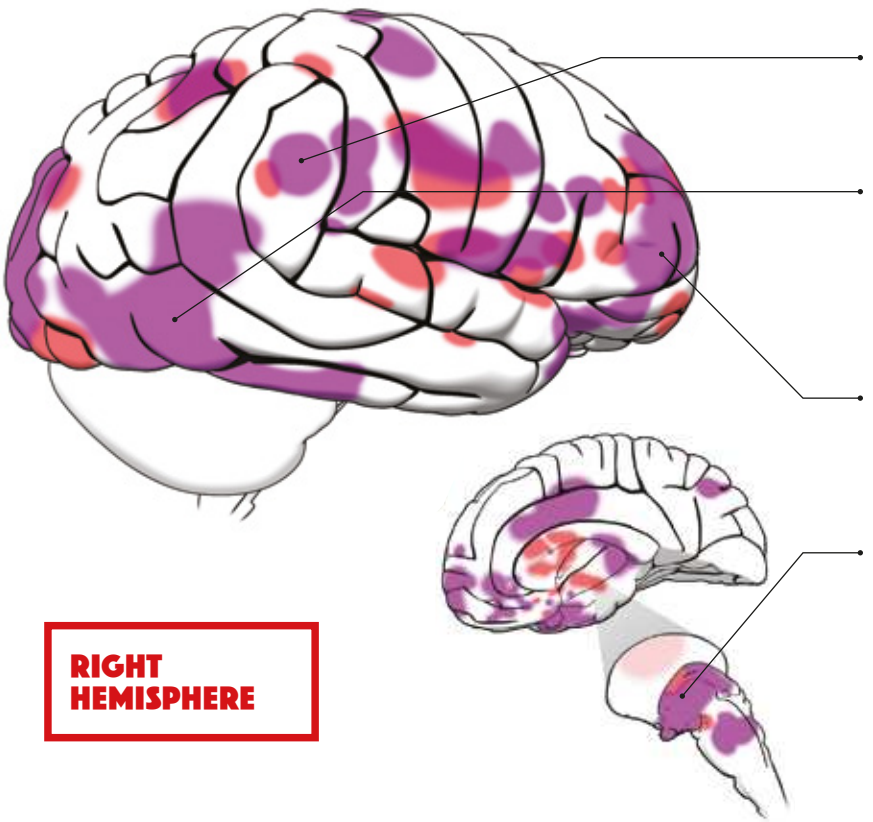
LEFT HEMISPHERE



Ventral tegmental area
A dopamine-rich region that underlies lust (both hemispheres) and love (right hemisphere only). It contributes to motivation, goal pursuit, emotion, reward expectancy, euphoria and habit formation.

Inferior parietal lobule
Associated with social-cognitive functions involving the abstract representation of the self, including body image and self-esteem, as well as metaphors and goal-directed actions.

Insula
Plays a role in emotion and self-awareness. The posterior (*back*) part perceives body states and visceral sensations; it is more active in lust than in love. The anterior (*front*) area forms abstract ideas about these body states; it revs up more in love than in lust.



Temporoparietal junction
Integrates bodily sensations and extracts a common, abstract mental representation from them. It also assists in the generation of empathy.

Occipitotemporal cortex
Linked with vision, associative memory, episodic retrieval and conceptual knowledge. The brain regions sustaining self-awareness and memories of experiences may tell this system what to interpret as sexually desirable and lovable and how to feel.

Prefrontal cortex
Generally associated with complex cognition, personality, decision making and social behavior. It also helps to regulate emotional arousal and the seeking of rewards.

Striatum
Involved in working memory and processes of reward, preferences, addiction and goal-directed behavior. As lust progresses to love, activity cascades from the bottom to the top, with the bottom active in response to sexual incentive cues and the top involved in tracking stimuli and activating stereotyped motor behaviors.

RIGHT HEMISPHERE

ILLUSTRATION BY GEORGE RETSECK; SOURCE: MODIFIED FROM "THE COMMON NEURAL BASES BETWEEN SEXUAL DESIRE AND LOVE: A MULTILEVEL KERNEL DENSITY FMRI ANALYSIS," BY STEPHANIE CACIOPPO ET AL., IN *JOURNAL OF SEXUAL MEDICINE*, VOL. 9, NO. 4; APRIL 2012

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to love, activity cascades from the back of the insula to the front, with the pleasing sensations of lust (sparked at the back) joined by the abstract feelings of affection (triggered at the front). A similar pattern for lust and love emerges in the striatum, this time traveling from bottom to top.

The research suggests that the strongest relationship—passionate love—involves activation of the home bases of both love and lust. Passionate love builds on the neural circuitry for lust, adding regions associated with reward expectancy, habit formation, and abstract representation and control to those associated with rewards for sensations and the satisfaction of cravings.

For any two individuals, the strongest relationship is not necessarily the best outcome: some couplings are just meant to be one-night stands. Love and lust can exist in any combination, with either, both or neither emotion present, and present to any degree. The combinations result in a variety of affiliations. When both people feel the same emotions, the relationship can range from passionate love (high love, high lust) to acquaintanceship (a little of each), with one-night stands (high lust, little love) and companionate love (as in a friendly marriage) in the middle. When the feelings of two people diverge, the results may be unwanted attention for one and unrequited love or lust for the other. The ideal state in any pairing is when the two people agree on their love-lust formula, creating a healthy balance between love and desire and the best chance for a stable, satisfying, monogamous relationship. But whatever the end point, getting there is half the fun. M

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LUST'S REWARD

For many women, orgasm remains elusive. Help may soon be at hand

BY **Kayt Sukel**

Six months after the birth of her second child, Patricia, a woman with an active and fulfilling sex life, found herself unable to achieve orgasm. "My partner and I tried everything," she says. "And it was so frustrating because I'd almost reach climax, time and time again, and then … nothing."

After a few months, her frustration led her to visit a local clinic for sexual disorders. "They brought in a social worker who asked me a lot of questions about abuse. They seemed worried about possible psychological causes," Patricia notes. After grilling her about her sexual habits, her marriage and other potential stressors, they suggested her inability to reach orgasm might be because of birth-related nerve damage. "They told me, 'Hopefully, the nerves will regenerate, but we don't know,'" she says. "And I left thinking, 'Wow, that was massively unhelpful.'"

They may say that all you need is love—but lust, love's partner in crime (or, as some may say, its evil twin), refuses to be denied. And like love, it begs to be fulfilled.

Patricia is far from alone in her frustration. The statistics vary, but most sources agree that less than one third of women consistently reach orgasm during sexual activity. If such an inability persists for more than six months and results in distress to the individual, the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM,* for short) classifies the condition as a psychosexual disorder: anorgasmia. The problem may be lifelong—the diagnosis for those who have never experienced an orgasm—or it may be acquired, as in Patricia's case. And although a small percentage of men acquire anorgasmia later in life, usually as the result of chronic medical issues, anorgasmia is primarily a disorder of women.

Today scientists are hard at work to understand the causes of anorgasmia and inhibited sexual response. Laboratories across the globe are using a variety of imaging techniques to

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pinpoint what happens in the brain during orgasm, how ideation can interfere with sexual response, and how our hormones can help—or hinder—climax. Clinicians are now pulling together these different research threads in the hope of discovering new, more effective treatments.

Before scientists can figure out how to help people who cannot have orgasms, though, they need to better understand what happens in the brains and bodies of people who can. "We're only really beginning to understand the orgasm, especially from a neuroscience perspective," says Barry R. Komisaruk, a neuroscientist at Rutgers University.

Orgasm and the Brain

The first comprehensive scientific studies of orgasm were led by William H. Masters and Virginia E. Johnson in the 1960s. By considering both physiological and psychological factors, the duo came up with the four-stage model of sexual response: excitement (or arousal), plateau (full arousal), orgasm and resolution. They arrived at their findings primarily through direct observation in the lab; many of their initial study participants were professional sex workers. But the pair did not have the tools to investigate the neurobiological factors that might be in play.

Neuroimaging techniques such as positron-emission tomography and functional MRI are giving neuroscientists a unique way to study the phenomenon. Komisaruk and his colleague Nan Wise, now an assistant research professor at Rutgers University and also a licensed sex therapist in New Jersey, have been using fMRI to study orgasm in a variety of populations.

I volunteered to be one of their guinea pigs. Komisaruk and Wise were looking to track the time course of the orgasm—identifying which areas of the brain are recruited during genital stimulation, during the orgasm itself and then postclimax. By doing so, they may be able to find potential candidates for what Komisaruk calls a "blockage," or an area that may interfere with orgasm when not activated properly.

When it came time for me to do my part at their lab in Newark, N.J., I found myself a bit apprehensive. My romantic soundtrack would consist of the spine-jangling clunks, clanks and whirs of the fMRI's magnetic apparatus—about as far from Barry White as you can get. Clad in a paper-thin cotton hospital johnny, I was slotted into the machine's claustrophobia-inducing tubular metal housing, my head immobilized in a tight mesh mask to keep it as still as possible while the magnet virtually sliced my brain. I wasn't feeling particularly sexy. Would I be able to achieve climax in such a setting?

I could but try. Using my hand to stimulate my clitoris while the scanner belched and bellowed overhead, I found that pure determination (and fear of disappointing the researchers calmly waiting in the control room) did the trick.

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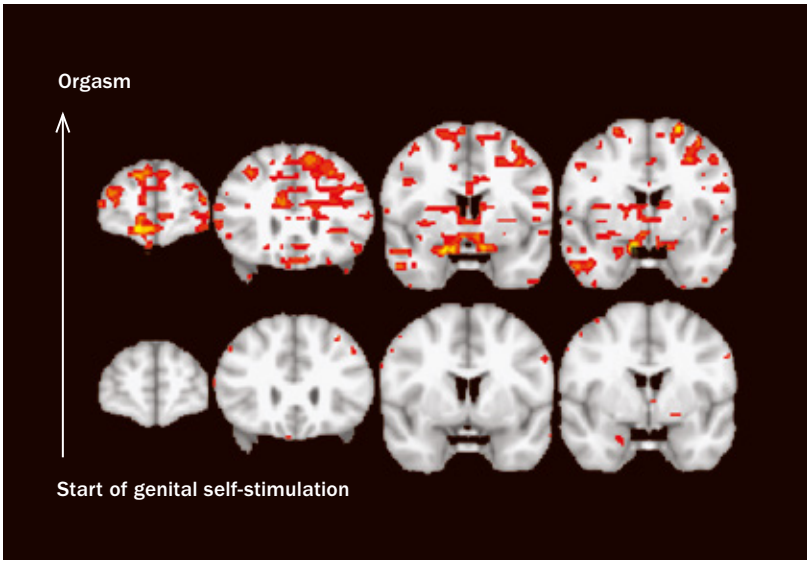
Within a few minutes, I pushed a button to let Komisaruk and Wise know that I had successfully donated my orgasm to science. The two then analyzed the data from my session, along with those from approximately a dozen other study participants, focusing on 80 discrete regions of the brain. They found a complex pattern of activation at the point of orgasm—suggesting many different ways to develop anorgasmia.

Parsing the interplay among all those regions is a daunting task. "We know the orgasm starts with activation in the sensory cortex," Komisaruk says. "But do anorgasmic people have a normal sensory cortex response? Is the sensory information not being integrated by other parts of the brain? We don't know yet."



Activation in four sections of the author's brain (*shown here*) is higher during orgasm than when genital stimulation began. Active regions include the basal forebrain, nucleus accumbens, amygdala, anterior hypothalamus, insula and anterior cingulate cortex.

Searching for Answers

In trying to identify the cause of anorgasmia, scientists are exploring different realms: the physiological, the psychological and the chemical. Cindy M. Meston, director of the Sexual Psychophysiology Lab at the University of Texas at Austin, points to a few well-known medical and physiological factors that inhibit orgasm, including the nerve damage that Patricia may have suffered. "There are vascular disorders, spinal cord injuries, neuropathy, drug effects from antidepressants and other medicines," Meston says. But, she adds, once you rule those factors out, no scientific evidence supports the idea that anorgasmia arises from dysfunctions in body systems.

A likelier culprit is the brain's frontal lobe, which is responsible for executive function—allocation of the mind's attention and control as circumstances require. Komisaruk's fMRI studies show that at the point of orgasm, the frontal pole, part of the frontal lobe, fires in tandem with areas in the temporal lobe associated with the senses and with regions down deep, near the brain stem, that are associated with rewards.

Those linkages may account for a barrier to orgasm that Masters and Johnson called "spectatoring"—staying outside of a sexual encounter to monitor and judge it instead of fully experiencing it. The frontal lobe governs all that monitoring and judgment. "You may not get to the high level of arousal needed for orgasm if you are paying attention to what you look like, or how you measure up to past partners, or what's happening in your relationship instead of what you're actually feeling and experiencing during sex," Meston says. "That kind of stuff is just not conducive to increasing arousal—and so it's going to get in the way of your orgasm."

The primacy of the mind in sexual response helps to explain a seemingly counterintuitive finding in clinical practice: treating anorgasmia is easiest in individuals for whom it has been a lifelong condition. The reason is that attitude is easier to alter than physiology. "It's often a shame thing," says Wise, who has treated many patients as a sex therapist, "and once you give someone permission to explore their body, to masturbate and learn what feels good, they figure it out. After all, you have to learn how to play your own instrument before you can play in a band."

Directed masturbation, introduced back in the 1970s by Julia Heiman, now director of the Kinsey Institute, and Joseph LoPiccolo, a sex researcher at the University of Missouri, has proved to be remarkably effective in the treatment of lifelong anorgasmia. The technique is much as it sounds—patients work with therapists on masturbatory activities during one-on-one sessions. "A ton of research shows that women who have never had an orgasm can learn how just by learning more about their sexual anatomy and how to explore their own bodies," Meston says, with directed masturbation succeeding for about 90 percent of participants. As early as 1978, for instance, a study led by researchers Alan J. Riley and Elizabeth J. Riley of the University of London found that 18 of 20 women were able to reach orgasm after following a directed masturbation program. Other studies have since shown similar success. Indeed, the greatest obstacle to an antidote for anorgasmia may be squeamishness about masturbating in the presence of a stranger.

Acquired anorgasmia could require a different kind of toolkit. Sometimes partner conflicts are to blame; they can often

THE AUTHOR

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IMAGE COURTESY OF NAN WISE AND BARRY R. KOMISARUK, *Rutgers University-Newark*

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be resolved with communication and psychotherapy. But what if talking does not provide the cure?

One day people may be able to fine-tune their own brain for a remedy. Komisaruk is optimistic that neurobiofeedback techniques will help in complex cases. In such a setup, a person hooked up to an electroencephalogram or an fMRI would see real-time displays of brain activity and learn to self-regulate and correct the problem. "Let's say we see that the genital sensory cortex response is normal but other areas down the line are not being activated," Komisaruk says. "We may be able to coach those with anorgasmia to voluntarily activate [those areas] and move themselves toward orgasm."

Biofeedback has proved effective in the treatment of conditions such as blood pressure regulation and anxiety and has even helped stroke patients regain function in paralyzed muscles. But given how much is still unknown about the timing and sequence of neural connections during orgasm, this kind of system remains an exciting possibility for another day.

Chemistry Matters

In the meantime, relief may come from intervention in our brain chemistry. Researchers studying animals and human patients have identified an array of neurochemicals that help to promote orgasm. Testosterone, a sex steroid, works its magic in the brain and the genitals, and although its role in female sexuality remains controversial, it is linked to feelings of both desire and arousal. Oxytocin, often called the "cuddle chemical," is released by the paraventricular nucleus—a small cluster of cells in the brain's hypothalamus—at the onset of climax. It then floods oxytocin receptors on cells in the nucleus accumbens, a reward center in the brain, and releases a glut of dopamine, a feel-good neurotransmitter, which delivers the pleasant rush that accompanies orgasm. To counter dopamine's effects (and keep us from having too much of a good thing, which could interfere with the brain's natural learning mechanisms or lead to addictive behaviors), the neurotransmitter serotonin and the protein prolactin act as brakes, resulting in feelings of satisfaction and relaxation after orgasm—although too much of either interferes with sexual response and may prevent orgasm from occurring.

The greatest obstacle to an antidote for anorgasmia may be squeamishness about masturbating in the presence of a stranger.

Researchers of anorgasmia are now trying to fine-tune this natural pharmacopeia. One new female desire drug, Lybridos, under development by Dutch research firm Emotional Brain, consists of serotonin-inhibiting buspirone coated in testosterone. Preliminary results from a four-week trial conducted in 2012 with 56 women who have hypoactive sexual desire disorder, or low libido, indicate that Lybridos may increase desire and orgasms more than a placebo or testosterone with a serotonin promoter, and further trials are ongoing. In August 2015 the Food and Drug Administration approved Addyi, a drug that targets neurotransmitters, for generalized hypoactive sexual desire disorder in premenopausal women. By most accounts, though, the reception to this drug has been lukewarm at best.

Waguih W. IsHak, a psychiatrist specializing in sexual medicine at Cedars-Sinai Medical Center in Los Angeles, has successfully treated anorgasmia with oxytocin and Dostinex, an antiprolactin agent, in individual case studies. But IsHak expresses caution. Anorgasmia is more complicated than an imbalance in one or two chemicals—and tinkering with these natural systems may result in fixes that may be only temporary or that bring unwanted side effects. "These are innovative interventions," IsHak says. "But they should be used only as a last resort after you've ruled out everything else."

Patricia, who found her own visit to the clinic "massively unhelpful," regained her ability to reach orgasm after about three years. Her nerve damage, the likely cause, healed over time. In the future, better understanding of the brain may help improve diagnosis and treatment for individuals like Patricia—showing which pathways are damaged and perhaps how to redirect them. Wise is cautious but hopeful: "In more complex cases of anorgasmia, we're probably looking at a combination of psychological, social and biological factors. If we can figure out how they interact as we better map out what is happening in the brain during orgasm—perhaps identifying critical structures or processes in the timeline that push people from arousal over into orgasm—there's the possibility we can do a lot more."

And that's an outcome many women are waiting for. M

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AFFAIRS OF THE LIPS

THE SEXUAL BRAIN

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LUST

Researchers are revealing hidden complexities behind the simple act of kissing, which relays powerful messages to your brain, body and partner

BY Chip Walter

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WHEN PASSION TAKES A GRIP, A KISS LOCKS TWO HUMANS TOGETHER IN AN EXCHANGE OF SCENTS, TASTES, TEXTURES, SECRETS AND EMOTIONS.

We kiss furtively, lasciviously, gently, shyly, hungrily and exuberantly. We kiss in broad daylight and in the dead of night. We give ceremonial kisses, affectionate kisses, Hollywood air kisses, kisses of death and, at least in fairy tales, kisses that revive princesses.

Lips may have evolved first for food and later applied themselves to speech, but in kissing they satisfy different kinds of hungers. In the body, a kiss triggers a cascade of neural messages and chemicals that transmit tactile sensations, sexual excitement, feelings of closeness, motivation and even euphoria.

Not all the messages are internal. After all, kissing is a communal affair. The fusion of two bodies dispatches communiqués to your partner as powerful as the data you stream to yourself. Kisses can convey important information about the status and future of a relationship. So much, in fact, that, according to some research, if a first kiss goes bad, it can stop an otherwise promising relationship dead in its tracks.

Some scientists believe that the fusing of lips evolved because it facilitates mate selection. "Kissing," said evolutionary psychologist Gordon G. Gallup, Jr., of the University at Albany, State University of New York, in a September 2007 interview with the BBC, "involves a very complicated exchange of information—olfactory information, tactile information and postural types of adjustments that may tap into underlying evolved and unconscious mechanisms that enable people to make determinations … about the degree to which they are genetically incompatible." Kissing may even reveal the extent to which a partner is willing to commit to raising children, a central issue in long-term relationships and one that is crucial to the survival of our species.

Kissing might have evolved from mouth-to-mouth feeding of primate infants by their mothers. It could then have morphed into a strategy for comforting hungry children in the absence of food—and later into a more general way of expressing affection.

FAST FACTS
KISS AND TELL

1. A kiss triggers a cascade of neural messages and chemicals that transmit tactile sensations, sexual excitement, feelings of closeness, motivation and even euphoria.
2. Kisses can convey important information about the status and future of a relationship. At the extreme, a bad first kiss can abruptly curtail a couple's future.
3. Kissing may have evolved from primate mothers' practice of chewing food for their young and then feeding them mouth to mouth. Some scientists theorize that kissing is crucial to the evolutionary process of mate selection.

Satisfying Hunger

Whatever else is going on when we kiss, our evolutionary history is embedded within this tender, tempestuous act. In the 1960s British zoologist and au-

PRECEDING PAGES: TIM FLACH *Getty Images*; THIS PAGE: KARL AMMANN *Corbis*

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thor Desmond Morris proposed that kissing might have evolved from the practice in which primate mothers chewed food for their young and then fed them mouth to mouth, lips puckered. Chimpanzees feed in this manner, so our hominid ancestors probably did, too. Pressing outturned lips against lips may have then later developed as a way to comfort hungry children when food was scarce and, in time, to express love and affection in general. The human species might eventually have taken these protoparental kisses down other roads until we came up with the more passionate varieties we have today.

Silent chemical messengers called pheromones could have sped the evolution of the intimate kiss. Many animals and plants use pheromones to communicate with other members of the same species. Insects, in particular, are known to emit pheromones to signal alarm, for example, the presence of a food trail, or sexual attraction.

Whether humans sense pheromones is controversial. Unlike rats and pigs, people are not known to have a specialized pheromone detector, or vomeronasal organ, between their nose and mouth. Nevertheless, biologist Sarah Woodley of Duquesne University suggests that we might be able to sense pheromones with our nose. And chemical communication could explain such curious findings as a tendency of the menstrual cycles of female dormitory mates to synchronize or the attraction of women to the scents of T-shirts worn by men whose immune systems are genetically compatible with theirs. Human pheromones could include androstenol, a chemical component of male sweat that may boost sexual arousal in women, and female vaginal hormones called copulins that some researchers have found raise testosterone levels and increase sexual appetite in men.

If pheromones do play a role in human courtship and procreation, then kissing would be an extremely effective way to pass them from one person to another. The behavior may have evolved because it helps humans find a suitable mate—making love, or at least attraction, quite literally blind.

We might also have inherited the intimate kiss from our primate ancestors. Bonobos, which are genetically very similar to us (although we are not their direct descendants), are a particularly passionate bunch, for example. Emory University primatologist Frans B. M. de Waal recalls a zookeeper who accepted what he thought would be a friendly kiss from one of the bonobos, until he felt the ape's tongue in his mouth!

Good Chemistry

Since kissing evolved, the act seems to have become addictive. Human lips enjoy the slimmest layer of skin on the human body, and the lips are among the most densely populated with sensory neurons of any body region. When we kiss, these neurons, along with those in the tongue and mouth, rocket messages to the brain and body, setting off delightful sensations, intense emotions and physical reactions.

Of the 12 or 13 cranial nerves that affect cerebral function, five are at work when we kiss, shuttling messages from our lips, tongue, cheeks and nose to a brain that snatches information about the temperature, taste, smell and movements of the entire affair. Some of that information arrives in the somatosensory cortex, a swath of tissue on the surface of the brain that represents tactile information in a map of the body. In that map, the lips loom large because the size of each represented body region is proportional to the density of its nerve endings [*see illustration on page 23*].

Kissing unleashes a cocktail of chemicals that govern stress, motivation, social bonding and sexual stimulation.

Kissing unleashes a cocktail of chemicals that govern human stress, motivation, social bonding and sexual stimulation. In one study, psychologist Wendy L. Hill and her student Carey A. Wilson, both then at Lafayette College, compared the levels of two key hormones in 15 college male-female couples before and after they kissed and before and after they talked to each other while holding hands. One hormone, oxytocin, is involved in social bonding, and the other, cortisol, plays a role in stress. Hill and Wilson predicted that kissing would boost levels of oxytocin, which also influences social recognition, male and female orgasm, and childbirth. They expected this effect to be particularly pronounced in the study's females, who reported higher levels of intimacy in their relationships. They also forecast a dip in cortisol because kissing is presumably a stress reliever.

But the researchers were surprised to find that oxytocin levels rose only in the males, whereas it decreased in the females, after either kissing or talking while holding hands. They concluded that females must require more than a kiss to feel emotionally connected or sexually excited during physical contact. Females might, for example, need a more romantic atmosphere than the experimental setting provided, the authors

THE AUTHOR

CHIP WALTER is author of *Last Ape Standing: The Seven-Million-Year Story of How and Why We Survived* (Walker & Company, 2013). You can find more details on the origins and joys of kissing in his book *Thumbs, Toes, and Tears: And Other Traits That Make Us Human* (Walker & Company, 2006). He is currently at work on his next book, *Cheating Death*, due out soon. For more information, visit www.chipwalter.com

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speculate. The study, which Hill and Wilson reported in November 2007 at the annual meeting of the Society for Neuroscience, revealed that cortisol levels declined for both sexes no matter the form of intimacy, a hint that stress does in fact drop when we kiss.

To the extent that kissing is linked to love, the act may similarly boost brain chemicals associated with pleasure, euphoria and a motivation to connect with a certain someone. In 2005 anthropologist Helen Fisher of Rutgers University and her colleagues reported scanning the brains of 17 individuals as they gazed at pictures of people with whom they were deeply in love. The researchers found an unusual flurry of activity in two brain regions that govern pleasure, motivation and reward: the right ventral tegmental area [*see illustration at right*] and the right caudate nucleus. Addictive drugs such as cocaine similarly stimulate these reward centers, through the release of the neurotransmitter dopamine. Love, it seems, is a kind of drug for us humans.

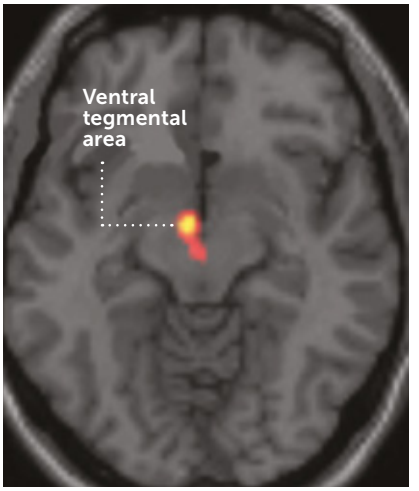
Kissing has other primal effects on us as well. Visceral marching orders boost pulse and blood pressure. The pupils dilate, breathing deepens and rational thought retreats, as desire suppresses both prudence and self-consciousness. For their part, the participants are probably too enthralled to care. As poet e. e. cummings once observed: "kisses are a better fate/than wisdom."

Litmus Test

Although choosing to kiss may not always be a wise decision, it can be pivotal to a relationship. "One dance," Alex "Hitch" Hitchens says to his client and friend in the 2005 movie *Hitch,* "one look, one kiss, that's all we get … one shot, to make the difference between 'happily ever after' and, 'Oh? He's just some guy I went to some thing with once.'"

Can a kiss be that powerful? Some research indicates it can be. In a 2007 survey, Gallup and his colleagues found that 59 percent of 58 men and 66 percent of 122 women admitted there had been times when they were attracted to someone only to find that their interest evaporated after their first kiss. The "bad" kisses had no particular flaws; they simply did not feel right—and they ended the romantic relationship then and there—a kiss of death for that coupling.

A kiss may convey subconscious information about the genetic compatibility of a potential mate.



Looking at someone with whom you are deeply in love, one study showed, activates the brain's ventral tegmental area, a pleasure center that addictive drugs also stimulate. If kissing is linked to love, it may similarly act like a drug in the brain.

The reason a kiss carries such weight, Gallup theorizes, is that it conveys subconscious information about the genetic compatibility of a prospective mate. His hypothesis is consistent with the idea that kissing evolved as a courtship strategy because it helps us rate potential partners.

From a Darwinian perspective, sexual selection is the key to passing on your genes. For us humans, mate choice often involves falling in love. Fisher wrote in her 2005 paper that this "attraction mechanism" in humans "evolved to enable individuals to focus their mating energy on specific others, thereby conserving energy and facilitating mate choice—a primary aspect of reproduction."

According to Gallup's findings, kissing may play a crucial role in the progression of a partnership but one that differs between men and women. In his study published in September 2007, Gallup and his colleagues surveyed 1,041 college undergraduates of both sexes about kissing. For most of the men, a deep kiss was largely a way of advancing to the next level sexually. But women were generally looking to take the relationship to the next stage emotionally, assessing not simply whether the other person would make a first-rate source of DNA but also whether he would be a good long-term partner.

"Females use [kissing] … to provide information about the level of commitment if they happen to be in a continuing relationship," Gallup told the BBC. The locking of lips is thus a kind of emotional barometer: the more enthusiastic it is, the healthier the relationship.

Because women need to invest more energy in producing children and have a shorter biological window in which to reproduce, they need to be pickier about whom they choose for a partner—and they cannot afford to get it wrong. So, at least for women, a passionate kiss may help them choose a mate who is not only good at fathering children but also committed enough to stick around and raise them.

That said, kissing is probably not strictly necessary from an evolutionary point of view. Most other animals do not neck and still manage to produce plenty of offspring. Not even all humans kiss. At the end of the 19th century Danish scientist Kristoffer Nyrop described Finnish tribes whose members bathed together but considered kissing indecent. In 1897 French anthropologist Paul d'Enjoy reported that the Chinese regard mouth-to-mouth kissing to be as horrifying as many people deem cannibalism to be. In Mongolia some fathers do not kiss their sons. (They smell their head instead.)

COURTESY OF HELEN FISHER *Rutgers University (brain scan)*

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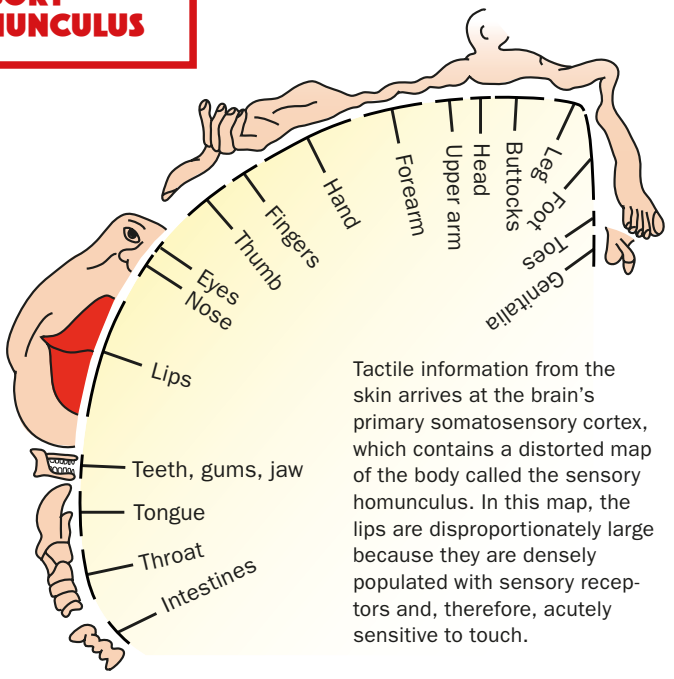
SENSORY HOMUNCULUS



Tactile information from the skin arrives at the brain's primary somatosensory cortex, which contains a distorted map of the body called the sensory homunculus. In this map, the lips are disproportionately large because they are densely populated with sensory receptors and, therefore, acutely sensitive to touch.

TAMI TOLPA; SOURCE: PENFIELD AND RASMUSSEN, 1950

In fact, up to 10 percent of humanity do not kiss lips, according to human ethology pioneer Irenäus Eibl-Eibesfeldt, formerly head of the Max Planck Society Film Archive of Human Ethology in Andechs, Germany, writing in his 1970 book, *Love and Hate: The Natural History of Behavior Patterns*. Fisher published a similar figure in 1992. Their findings suggest that some 650 million members of the human species have not undertaken the art of osculation, the scientific term for kissing; that is more than the population of any nation on earth except for China and India.

For those cultures that do kiss, however, osculation conveys additional hidden messages. Psychologist Onur Güntürkün of the Ruhr-University of Bochum in Germany surveyed 124 couples kissing in public places in the U.S., Germany and Turkey and found that the partners tilted their heads to the right twice as often as to the left before their lips touched. Right-handedness cannot explain this tendency, because being right-handed is four times more common than is the act of kissing on the right. Instead Güntürkün suspects that right-tilted kissing results from a general preference that develops at the end of gestation and in infancy. This "behavioral asymmetry" is related to the lateralization of brain functions such as speech and spatial awareness.

Nurture may also influence our tendency to tilt to the right. Studies show that as many as 80 percent of mothers, whether right-handed or left-handed, cradle their infants on their left side. Infants cradled, face up, on the left must turn to the right to nurse or nuzzle. As a result, most of us may have learned to associate warmth and security with turning to the right.

Some scientists have proposed that those who tilt their heads to the left when they kiss may be showing less warmth and love than those who tilt to the right. In one theory, tilting right exposes the left cheek, which is controlled by the right, more emotional half of the brain. But a 2006 study by naturalist Julian G. Greenwood and his colleagues at Stranmillis University College in Belfast, Northern Ireland, counters this notion. The researchers found that 77 percent of 240 undergraduate students leaned right when kissing a doll on the cheek or lips. Tilting to the right with the doll, an impassive act, was nearly as prevalent among subjects as it was among 125 couples observed osculating in Belfast; they tilted right 80 percent of the time. The conclusion: right-kissing probably results from a motor preference, as Güntürkün hypothesized, rather than an emotional one.

Despite all these observations, a kiss continues to resist complete scientific dissection. Close scrutiny of couples has illuminated new complexities woven throughout this simplest and most natural of acts—and the quest to unmask the secrets of passion and love is not likely to end soon. But romance gives up its mysteries grudgingly. And in some ways, we seem to like it that way. **M**

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THE SEXUAL BRAIN

5/7

LUST

THE SUNNY SIDE OF SMUT

For most people, pornography use has no negative effects—and it may even deter sexual violence

BY **Melinda Wenner Moyer**

It used to be tough to get porn. Renting an X-rated movie required sneaking into a roped-off room in the back of a video store, and eyeing a centerfold meant facing down a store clerk to buy a pornographic magazine. Now pornography is just one Google search away, and much of it is free. Age restrictions have become meaningless, too, with the advent of social media—one teenager in five has sent or posted naked pictures of themselves online, according to the National Campaign to Prevent Teen and Unplanned Pregnancy.

With access to pornography easier than ever before, politicians and scientists alike have renewed their interest in deciphering its psychological effects. Certainly pornography addiction or overconsumption seems to cause relationship problems. But what about the more casual exposure typical of most porn users? Contrary to what many people believe, recent research shows that moderate pornography consumption does not make users more aggressive, promote sexism or harm relationships. If anything, some researchers suggest, exposure to pornography might make some people *less* likely to commit sexual crimes.

Does Porn Harm Women?

The most common concern about pornography is that it indirectly hurts women by encouraging sexism, raising sexual expectations and thereby harming relationships. Some people worry that it might even incite violence against women. The data, however, do not support these claims. "There's absolutely no evidence that pornography does anything negative," says Milton Diamond, director of the Pacific Center for Sex and Society at the University of Hawaii at Manoa. "It's a moral issue, not a factual issue."

In 2007 researchers at the University of Zagreb in Croatia surveyed 650 young men about their pornography use and sex lives. As they reported in the *Archives of Sexual Behavior,* the scientists found that users of mainstream, nonviolent pornography were neither more nor less sexually satisfied than nonusers. Both groups felt the same degree of intimacy in their current or recent relationships and shared the same range of sexual experiences. But when it came to violent or fetishist porn, the groups diverged. Consumers of these types of pornography appeared to masturbate more frequently, have more sexual partners over the course of their life, and experience slightly less relationship intimacy than their nonviolent porn–viewing counterparts.

Regular pornography use does not seem to encourage sexism, either. In a 2015 study, researchers at the University

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of Western Ontario surveyed more than 25,000 men and women and found that those who had viewed a pornographic film in the past year were more supportive of gender equality than those who had not. And in 2007 Alan McKee, a cultural studies expert at the Queensland University of Technology in Australia, designed a questionnaire to assess sexist tendencies. He enclosed his survey in shipments of pornographic material distributed by a mail-order company and also posted it online. Responses from 1,023 pornography users indicated that the amount of pornography the subjects consumed did not predict whether they would hold negative attitudes toward women. The survey respondents who were most sexist were generally older men who voted for a right-wing political party, lived in a rural area and had a lower level of formal education.

But the questionnaire may have missed a key nuance. In a study published in 2004 in the *Journal of Psychology & Human Sexuality,* researchers at Texas Tech University administered a different survey to male and female college students and found that although consumers of pornography did not display more negative attitudes toward women, they were more likely than other respondents to believe that women should be protected from harm—what the investigators call "benevolent sexism."

Self-Medicating with Fantasy

Perhaps the most serious accusation against pornography is that it incites sexual aggression. But not only do rape statistics suggest otherwise, some experts believe the consumption of pornography may actually reduce the desire to rape by offering a safe, private outlet for deviant sexual desires.

Rape rates in the U.S. increased from 1960 to 1992, but "after porn became widespread on the Internet, around 1993, rape rates began their precipitous decline," says Christopher J. Ferguson, now an associate professor of psychology at Stetson University in Florida. (There was, however, a slight uptick in 2014.) The same goes for other countries: as access to pornography grew in once restrictive Japan, China and Denmark in the past 40 years, rape statistics plummeted.

Within the U.S., the states with the least Internet access between 1980 and 2000—and therefore the least access to Internet pornography—experienced a 53 percent increase in rape incidence. And the states with the most access experienced a 27 percent drop in the number of reported rapes, according to a paper published in 2006 by Anthony D'Amato, a law professor at Northwestern University.

Sex offenders say that pornography helps them keep their abnormal sexuality within the confines of their imagination.

It is important to note that these associations are just that—associations. They do not prove that pornography is the cause of the observed crime reductions. Nevertheless, the trends "don't fit with the theory that rape and sexual assault are in part influenced by pornography," Ferguson explains. "I think we can say the evidence just isn't there."

What if it turns out that pornography use actually reduces the desire to rape? It is a controversial idea, but some studies support it. In 1992 Richard Green, a psychiatrist at Imperial College London, disclosed in his book *Sexual Science and the Law* that patients requesting treatment in clinics for sex offenders commonly say that pornography helps them keep their abnormal sexuality within the confines of their imagination. "Pornography seems to be protective," Diamond says, perhaps because exposure correlates with lower levels of sexual repression, a potential rape risk factor.

A Personal Concern

Repression seems to figure prominently into the puzzle of pornography. In 2009 Michael P. Twohig, a psychologist at Utah State University, asked 299 undergraduate students whether they considered their pornography consumption problematic; for example, causing intrusive sexual thoughts or difficulty finding like-minded sex partners. Then he assessed the students with an eye to understanding the root causes of their issues.

It turns out that among porn viewers, the amount of porn each subject consumed had nothing to do with his or her mental state. What mattered most, Twohig found, was whether the subjects tried to control their sexual thoughts and desires. The more they tried to clamp down on their urge for sex or porn, the more likely they were to consider their own pornography use a problem. The findings suggest that suppressing the desire to view pornography, for example, for moral or religious reasons, might actually strengthen the urge for it and exacerbate sexual problems.

It's all about "personal views and personal values," Twohig says. In other words, the effects of pornography—positive or negative—have little to do with the medium itself and everything to do with the person viewing it. M

THE AUTHOR

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WHEN AROUSAL IS AGONY

Sexual dysfunction can emerge when certain nerves start misfiring. Could antidepressants be partly to blame?

BY Cat Bohannon

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A WOMAN WE'LL CALL SALLY LIVED IN A SMALL TOWN DEEP IN THE HEART OF TEXAS HILL COUNTRY,

a long, rippled patch of land wet with creeks and big oaks growing right out of the water. It's mostly middle class, mostly Christian, the sort of place where you don't have to lock your doors because you already know all your nosy neighbors. She lived with her husband, and her kids were grown.

One day her husband took her out for a ride on his motorcycle. When they picked up speed, she was sucked off the back. Sally flew through the air, legs akimbo, and landed on her bottom. The doctors at the ER told her she had compressed a number of disks in her spine, broken her tailbone and snapped her wrist in three places. "Yeah, I messed myself up pretty good," she says.

After running a gauntlet of surgeries, drugs and physical therapy, her spine started to heal. Things were looking up. She was having some trouble with her bladder—"felt like I needed to pee all the time"—but doctors were taking care of that.

Then it happened.

Sally got really, really horny.

But she didn't want to be. Though she didn't know it at the time, Sally had restless genital syndrome (ReGS), a recently discovered, mysterious disease that causes maddening sexual arousal for thousands of men and women worldwide. It's not sex addiction. It has little to do with conscious desire. Though it causes psychological distress—many patients become suicidally depressed—ReGS is a peripheral wiring problem.

Triggered by some combination of physical trauma, medication and hormonal changes, the nerves of the pelvis send waves of unwanted and disturbing signals to the brain. For example, you might feel the need to masturbate for 12 hours at a stretch. You might feel a constant buzzing, tingling sensation in your crotch. You might have an orgasm because your jeans brushed you the wrong way in the supermarket. You might start to avoid both your jeans and the supermarket. Soon your life will be nearly impossible to manage.

The renowned sexologist Sandra R. Leiblum originally discovered ReGS in 2001. Though most scientists think the disorder is fairly rare, clinicians in the field say diagnoses are on the rise, at least in part because it is becoming better known. Irwin Goldstein, director of sexual medicine at Alvarado Hospital in San Diego, has seen hundreds of patients with ReGS in his practice. At national conferences, he will ask from the podium how many clinicians believe they have seen patients with ReGS, and two thirds of the audience will raise their hands. David Goldmeier, a sexologist at St. Mary's Hospital in London, conducted a survey at a walk-in clinic for sexual disorders and found that a full third of the women had some kind of spontaneous or persistent genital arousal. But far fewer of his subjects fully qualified for a ReGS diagnosis, and none of these tiny samples can tell us how many people really have it.

Like many patients with sexual dysfunction, Sally found herself deep in the American heartland with a startling realization: she was not entirely "in charge down there." But sexuality is not a top-down system. The brain doesn't just decide to become sexually excited and then send signals to the appropriate spots. The brain and the peripheral nervous system work together to build an individual's sexuality—and their rapid-fire conversation can become prickly when the two disagree.

Searching for a Diagnosis

Sally calls her husband a "trooper." In the beginning, he was very supportive, even as his wife alternated between crazed sexpot and withdrawn depressive, even though he didn't really—couldn't really—understand. He drove her to doctor after doctor, although driving was the worst. The low vibration of a car seat had become unbearable for her.

There are essentially four places in the world where doctors know the latest about ReGS: California, New Jersey, the U.K. and the Netherlands. Sally did not live in any of these places. Though eventually she would discover all the top names in this burgeoning field, the only doctor she knew at first was her urologist. She still felt like she had to pee all the time.

Like many people suffering from ReGS, Sally described her symptoms with electrical metaphors—a "shock," "buzzing" or a "zap," that feeling of being right at the edge of an orgasm, the itchy, breathless *before*. It wasn't pleasurable, however. It was painful—and

FAST FACTS
BAD VIBRATIONS

1. Restless genital syndrome is a recently discovered, mysterious disease that causes maddening sexual arousal for thousands of men and women worldwide.
2. Many patients with restless genital syndrome link certain popular antidepressants—selective serotonin reuptake inhibitors—to the start of their symptoms. Injuries or hormonal changes may also play a role in some instances.
3. The brain and the peripheral nervous system work together to build an individual's sexuality. Trouble ensues when these two disagree.

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once it started, it wouldn't stop. It came in waves, sometimes for hours a day. If Sally had an orgasm, it only got better for a minute or two, and then the pain returned. "I couldn't think of anything worse to happen to a human being," Goldstein says. "To be at the throes of high arousal, almost anything pushes you into it, and [that] brief refractory period hoping you can get some respite, but you don't, it comes right back."

The accepted wisdom is that ReGS involves some malfunction of the pudendal nerve complex. Hooking onto the bottom of the spine, the pudendal nerve is a thick bundle of fibers that branches out to innervate the lower pelvis. One branch controls the anal sphincter, another the urethral sphincter and a third dorsal branch extends, in men, to the end of the penis and, in women, to the fat club of the clitoris. It's generally a well-liked part of the peripheral nervous system.

It came in waves, sometimes for hours a day. If Sally had an orgasm, it only got better for a minute or two, and then the pain returned.

At Haga Hospital in the Hague, neuropsychiatrist Marcel D. Waldinger runs one of the world's only clinics specializing in ReGS. He noticed in 2008 that ReGS symptoms tended to occur together with an overactive bladder and restless legs syndrome—the persistent, nervous urge to twitch one's legs because they feel "strange" or "tingly." Thinking of the way the sacrum serves as a nerve hub for both the pelvis and the legs, Waldinger realized these disorders could be essentially the same problem: chronic aberrant neural activity around the sacrum, just referring to different places—the sciatic nerve for restless legs or the pudendal nerve complex for restless genitals or overactive bladders. Sally fit this profile: her bladder was what led her to a urologist in the first place.

Such academic discussions are all well and good, but the sciatic nerve doesn't challenge a woman's self-worth quite the way the pudendal does. One quiet night in Texas, Sally did not know what was wrong with her yet. She had taken to drinking wine alone at home because it seemed to numb her a little. She also took pills to sleep. She remembers talking on the phone with her sister, drinking from the bottle, taking some pills, and then drinking more and taking more pills. Her sister was telling her to stop, to hang in there, that it wasn't

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worth it. Did she want to die? Maybe? Maybe. They found her in time.

Luckily, Sally's urologist had recently gone to a conference where she had heard Goldstein speak about his research on ReGS. Sally had her first glimmer of hope in years. Now she had a diagnosis that felt right to her—"I wasn't crazy. It was real. A real thing," she says. Finally she could find a doctor for what she was actually suffering from: not her bladder, but her nervous system. As for why her body went haywire, the accident wasn't the only culprit. It probably also had something to do with her uterus: Sally didn't have one.

The Many Lives of Serotonin

Sally had been artificially menopausal for many years before the accident. She had had a hysterectomy at age 27, with little in the way of hormone therapy since. Men and women both have a wide variety of sex hormones—estrogens, androgens and progestogens—in a sex-typical balance. In women, that balance changes with menopause. Women diagnosed with ReGS vastly outnumber men, with menopausal women forming the largest segment of ReGS cases. And Sally's body was in a kind of extreme menopause because she had neither a uterus nor ovaries.

One of the many roles of estrogens in the body is their influence on serotonin, a neurotransmitter that, among other duties, helps to regulate blood flow. Vasoregulation is incredibly important for sexual function. Just as it enables erections in men, the dilation of blood vessels in a woman's pelvis swells tissue in and around the vagina and spurs the production of lubricating mucus. The nerves of the genitals become extra responsive, and the entire area gets ready for coitus. In part through their actions on serotonin, the estrogens—especially estradiol—normally facilitate this process. In women of reproductive age, blood levels of estradiol correlate positively with serotonin levels. As estradiol decreases with menopause, the genitals can become less sexually responsive—not from any psychological predetermination, but because of what is essentially a plumbing problem.

The transmission of sexual signals along the dorsal nerve may be turned on, not off, by default.

Menopause is not the only way to manipulate serotonin levels, however. The most popular type of antidepressant, selective serotonin reuptake inhibitors (SSRIs), also targets serotonin. These medications can similarly diminish blood flow in the pelvis, thereby blunting sexual responsiveness. Erectile dysfunction and its analogue in women are such common side effects of SSRIs that some doctors are now in the habit of prescribing a cocktail of antidepressants and Viagra.

Many patients with ReGS link SSRIs to the start of their symptoms. Goldmeier and Leiblum published a paper on the link between SSRIs and ReGS in 2008; more papers have followed. In most cases, symptoms seem to start after either reducing dosage or discontinuing SSRIs. It has been known for some time that going off these drugs can cause negative side effects, including problems with mood, dizziness, headaches, digestion and sexuality. In 1996 the Eli Lilly company—flush with recent Prozac money—held a symposium on these issues. One study found that up to 80 percent of patients suffered from withdrawal symptoms, although after the symposium these were called "discontinuation syndrome."

SSRIs boost levels of serotonin at synapses (the junctions between neurons) by blocking neurons from corralling leftover serotonin after the neurotransmitter has done its job. The body may adapt to the excess by reducing sensitivity to serotonin overall. After a patient quits or lowers the dose of an SSRI, neurons can quickly scoop up the free-floating molecule, causing serotonin levels to drop even while the nervous system might still be less sensitive to serotonin—a double whammy. In patients who go on to develop ReGS, this change could lead to a vascular system that neither constricts enough nor dilates enough under the appropriate circumstances. The pelvic nerves may also go on the fritz, becoming chronically hyperstimulated. For some, ReGS will mysteriously go away after a month or two. For others, such as Sally, the disease gets progressively worse. Even more inexplicably, some patients get relief from taking an SSRI when their symptoms flare up.

As Waldinger describes it, ReGS is a kind of umbrella diagnosis: lots of different things can cause the neuronal misfiring associated with ReGS. No one knows for sure why Sally got it, but she had risk factors. Sally had once taken SSRIs for depression, but she was not on them when her ReGS symptoms developed; she had experienced dramatic hormonal changes after her hysterectomy, however, and, of course, she had suffered severe trauma to the pelvis.

Finding the Code

Newly armed with a name for her disorder, Sally wasn't sure what to do. But she couldn't do nothing. She was tired of feeling like a "live wire."

Sally had already quit her job. Many ReGS patients lose their jobs. As she says, "You just can't function." Unfortunately, they are also unlikely to be eligible for disability benefits in the U.S. Although ReGS is now fairly well documented in the scientific literature, the disorder is not yet named in the current *Diagnostic and Statistical Manual of*

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time. The result: insurance will not cover it. Instead some patients are diagnosed with interstitial cystitis—inflammation of the bladder, producing pain and the constant need to urinate.

Waldinger has a novel theory for why patients like Sally always feel on the verge of an orgasm. He thinks the transmission of sexual signals along the dorsal nerve to the lower spine may be turned on, not off, by default. House lamps work that way: once the lamp's cord is plugged in, electricity always runs between the wall and the lamp. The switch simply permits that energy to reach the bulb's filament. In this line of thought, your dorsal nerve may be, under normal circumstances, always ready to send signals to your spine that say, "Hey, orgasm incoming." Yet because of a complex inhibitory system surrounding the nerve, we only "hear" that signal at the right time.

Much of the human nervous system relies on complex arrangements of excitation and inhibition. One neuroscientist in Eric R. Kandel's laboratory at Columbia University estimates that roughly 20 percent of the neurons in the brain are inhibitory. For some patients with ReGS, Waldinger suspects that a specific kind of neuropathy—a problem with small fibers around the dorsal nerve—interrupts an inhibitory system, leaving the switch jammed on.

Mental Disorders (*DSM-5*) or the *International Classification of Diseases*. These two bibles of medical diagnosis—one for mental disorders, one for more general epidemiology—are the main points of reference for how American Medicare and insurance companies generate "codes" for claims.

In the *DSM-5*, a condition called "substance/medication-induced sexual dysfunction" mentions the SSRI fluoxetine, but the diagnosis refers to problems of diminished libido such as erectile dysfunction, not rampant, life-crippling sexual sensations. And, of course, ReGS is not always caused by medication.

Like any bible, the *DSM* is slow to change. The book still listed homosexuality as a pathological "sexual deviation" in 1973. Conditions based on physical neuralgias move a bit faster, but debates about sexual disorders tend to linger on a strange bridge between psychological and physiological, which could leave ReGS without an official stamp for some

Unfortunately, patients with restless genital syndrome are unlikely to be eligible for disability benefits in the U.S.

Whatever the underlying mechanism for the neural misfiring, dampening or interfering with that signal is the goal of every type of treatment available for patients like Sally. Every clinician in the know will prescribe a combination of psychotherapy to cope with the pain and embarrassment, hormonal or

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neurotransmitter drug therapies to deal with the nerves, and sometimes mechanical intervention. Some patients receive anesthetic nerve blocks to mute the dorsal nerve or the pudendal complex overall, but these blocks tend to wear off over time, and the injections can be phenomenally painful.

Waldinger's practice has seen some success with TENS units, small boxes that send electrical signals down to nerves through the skin—in this case, wiring up women's genitals like something out of a steampunk magazine. ("TENS" stands for transcutaneous electrical nerve stimulation.) Goldstein sends some of his patients to a hospital in Michigan for a $60,000-plus surgery in which a kind of pacemaker is installed near the buttocks, sending controlled bursts of electricity down toward the sacrum. Both interventions are designed to interfere with, and thus impede, the errant nerve signal. Among other remedies, patients may try botulinum toxin, electroconvulsive therapy, or surgery to aspirate and seal cysts in the lower spine—a condition that behavioral neuroscientist Barry Komisaruk of Rutgers University has recently linked to ReGS.

Some patients opt for a $60,000-plus surgery in which a kind of pacemaker is installed near the buttocks.

Every patient's treatment is a bit of an experiment. No single intervention has been proved effective in the majority of cases, so doctors have to approach treatment for ReGS as trial and error, taking account of each individual's particular history and symptomatology.

Sally didn't have many options. Based on a recommendation from her urologist, she was starting to think a visit to Goldstein in San Diego sounded pretty good. She just wasn't sure she could afford it. Texas is a long way from California, and Goldstein's clinic is expensive. Yet his patients hold him in a

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kind of reverence. Of all the scientists and clinicians who work with ReGS, he is the most hopeful about treatment outcomes, and many patients of his have seen some relief. Without insurance, however, trial-and-error treatments rack up significant medical bills. One woman took out a second mortgage on her home to afford it all.

"I Wish *My* Wife Had That Problem"

Shame is a huge barrier to more comprehensive clinical research into ReGS. Sally needed to be called "Sally" in this story, rather than her real name, because she lives in a small, conservative town. Other patients with ReGS have even stronger motivations to keep quiet. Goldstein says people could be fired: "A kindergarten teacher having sexual feelings in her classroom—can you imagine?" Women with the disorder often feel ashamed to come forward and speak with their (frequently male) doctors. Among those who have, many feel frustrated by the responses they receive. One physician Sally had consulted told her, "Gosh, I wish *my* wife had that problem."

Perhaps we can forgive that particular faux pas. His patient was a middle-aged woman, and people continue to conflate a woman's menopause—the cessation of her menstrual cycle—with the death of her sex life. Libido naturally decreases with age in many populations, but there is no evidence that it goes away entirely. Nor does it wane particularly in women, although many women expect it to. It is unclear whether this very belief—that they are not supposed to be aroused so often—is part of why women vastly outnumber men right now in the rank and file of ReGS. Maybe women are more likely to report their symptoms to their doctors. Men with the disease typically say they felt ashamed to go to the doctor with a complaint because sexual desire is supposed to be "manly."

Even Sally's husband, who loved her deeply, struggled to reconcile his wife's illness with old ideas about women's sexuality. He worried, Sally says, that he "wasn't enough" for her, that maybe she just wanted to sleep with other people, that she was not taking care of him like a wife should. They were fighting a lot. That was one of the reasons Sally eventually decided to seek treatment at Goldstein's clinic.

Mostly she was scared her husband would leave her and take the car, and she'd be left with nothing.

Sally wasn't sure why she took the car. She had reasons—she would need a car in California, planes were expensive—but mostly she was scared her husband would leave her and take the car, and she'd be left with nothing.

Sometimes you just make a decision in the middle of Crazy, and that decision anchors you. For Sally, that decision meant driving to California sitting on big bags of ice from gas stations to numb her labia and clitoris. She had a sister in California, a place to stay. It's a 26-hour drive, with two ways to do it: I-10, which takes you through western Texas badlands and the White Sands Missile Range, or up north to I-40 for Albuquerque and Flagstaff, just south of the Grand Canyon. The northern route takes a little longer, but it goes through more proper towns, and proper towns have ice machines. Sally went north. It took her four days.

Sally kept driving. The long, black throat of the road squeezing her little car forward, forward, through the desert, over mountains, one gas station after another, stopping only to pee, to barely sleep, her crotch numbed by an ice pack and still pulsing, still there, the anesthesia of the road dulling her brain, her husband on the phone, crazy with rage, Sally kept driving. Maybe he'd leave her. Maybe he wouldn't. Just drive. Her sister was waiting for her. That new doctor, waiting for her. Just drive. Drive.

Today Sally still has ReGS—or, as Goldstein calls it, persistent genital arousal disorder (PGAD), the syndrome's original name. Since becoming a patient at Goldstein's clinic, Sally has tried a number of treatments, including hormones, talk therapy and nerve blocks, with little success. She eventually got the surgery in Michigan, which helped greatly. Sex is still a trigger, but she can swim, do Zumba and even drive again without pain. Time will tell if the improvement lasts. For now, she is struggling with the medical bills—her husband is the breadwinner, and there isn't much bread to go around. M

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SEX AND THE SECRET NERVE

Might a little-known cranial nerve be the route by which human pheromones turn us on?

BY R. Douglas Fields

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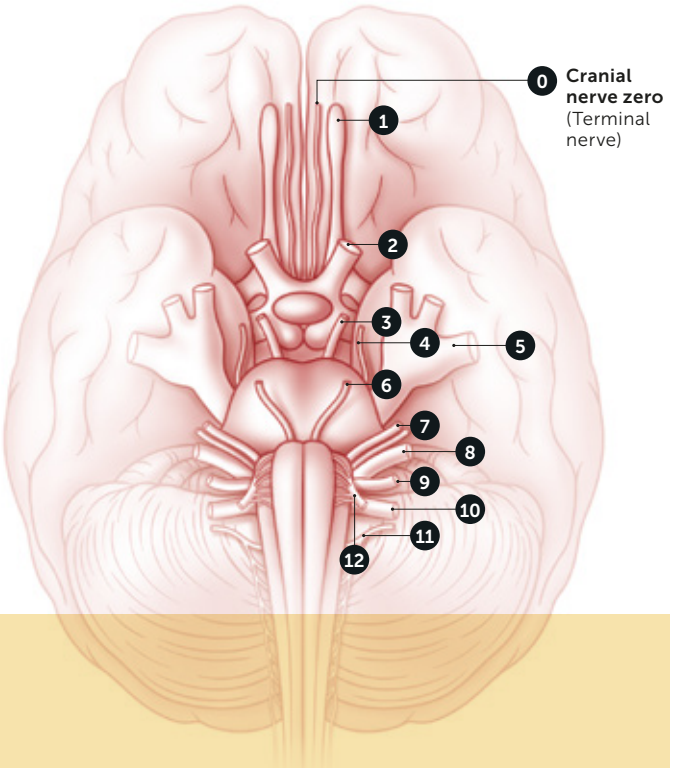
WE STOOD AROUND THE BODY PLANNING OUR AUTOPSY STRATEGY. A SCALPEL, WE REALIZED, WAS NOT GOING TO BE THE APPROPRIATE IMPLEMENT FOR THIS CORPSE, SO WE MADE OUR DECISION.



MYSTERIOUS NERVE

Cranial nerves emerge from the floor of the brain in pairs; each pair is numbered from the front of the brain (closest to the forehead) to the back (near the spinal cord). Cranial nerve zero (also called the terminal nerve) is not in typical textbooks. Anatomists historically missed the thin nerve, perhaps because it is often inadvertently pulled off along with the tough membranes that wrap the brain.

FAST FACTS
SEX SCENTS

1. Most textbook diagrams of the human brain show a dozen pairs of cranial nerves, discovered centuries ago and numbered from one to 12. Missing from this picture is a tiny, relatively unstudied nerve dubbed nerve zero, or the terminal nerve.
2. Nerve zero connects the brain to the nose, which suggests that it may play a role in detecting pheromones—chemical cues, sometimes odorless, used in sexual communication.
3. If pheromone messages can travel directly to the hot-button sex regions of the brain via nerve zero, they may be influencing our sexual behavior without us realizing it.

It took all three of us to muscle the slippery black bulk of the pilot whale into the screaming blur of the band-saw blade.

The whale had died of natural causes, after a distinguished military tenure conducting deep-sea operations for the U.S. Navy, which sends marine mammals to places where humans cannot safely go. In death, it was going to perform one more service—provide us with information about its magnificent brain. The navy had invited researchers at the Scripps Institution of Oceanography in La Jolla, Calif., to come to its base in San Diego in the mid-1980s, and I had joined them. Dressed like fishmongers in black rubber smocks and boots, anatomist Leo S. Demski, then visiting from the University of Kentucky, veterinarian Sam H. Ridgway, now at the National Marine Mammal Foundation, and I sought to unravel a scientific mystery. It was imperative that we learn whether the whale had a certain cranial nerve—for reasons that will soon become apparent.

Every picture of the human brain you have seen is wrong. Something is missing, and the omission is not trivial. The dirty little secret is a tiny, relatively unstudied nerve sprouting from the base of the brain whose function is only now becoming clear: subliminal sexual attraction. Many scientists believe that pheromones, those silent chemical messages exchanged by members of the opposite sex in search of mates, relay subconscious signals to the brain through this obscure nerve. Others are skeptical. How can a little-studied nerve be in-

PRECEDING PAGES: NISIAN HUGHES *Getty Images (silhouette)*; RICHARD NEWSTEAD *Getty Images (man's hand)*; TAMI TOLPA; SOURCE: "NERVUS TERMINALIS (CRANIAL NERVE ZERO) IN THE ADULT HUMAN," BY G. N. FULLER AND P. C. BURGER, IN *CLINICAL NEUROPATHOLOGY*, VOL. 9, NO. 6; NOVEMBER 1990 *(brain diagram)*

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volved in activities with such important implications for human behavior—especially when anatomists have scrutinized every minute detail of the human body for centuries? Could there be more to choosing a mate than we consciously realize? Researchers like us have been working to find out.

Tracking this mysterious cranial nerve brought me to the pilot whale, as a model for understanding our fellow mammals. For reasons that I will explain, it was particularly important to find out if this nerve exists in whales.

Most nerves enter the brain through the spinal cord, but some—the cranial nerves—enter the brain directly. The existence of some of the cranial nerves, if not their precise function, has been known since the time of Greek philosopher and physician Galen (who lived circa A.D. 129–210). Today we understand that they provide the vital senses of smell, sight, hearing, taste and touch; they are also involved in the movement of the eyes, jaw, tongue and face. Cranial nerves emerge from the floor of the brain in pairs, like a multilegged centipede. As medical students know, each nerve pair is numbered in sequence from the front of the brain (closest to the forehead) to the back (near the spinal cord).

Cranial nerve one is the olfactory nerve. All scents enter our brain through this nerve. Next, immediately behind the olfactory nerve, is cranial nerve two, the optic nerve. The optic nerve connects the eyes to the brain. The pairs continue in sequence to the 12th cranial nerve, which extends from the tongue and enters the brain near the spinal cord. Each pair was carefully identified, numbered and studied in detail. Then, in the late 1800s, neuroanatomists had their tidy understanding of cranial nerves attacked, so to speak, by a shark.

In 1878 German scientist Gustav Fritsch noticed a slender cranial nerve entering the brain of a shark just ahead of all the known nerves. No one had noticed it before. Even today countless anatomy students dissect dogfish sharks, but few detect the nerve because it is still not in the textbooks.

The discovery put anatomists in a predicament. Because it was located in front of the olfactory nerve, the new nerve should have been named cranial nerve one. But renumbering all the cranial nerves at this point was impossible because their identities were deeply entrenched in the medical vocabulary. The solution was to christen this new find "nerve zero," the "terminal nerve." Most people forgot about it altogether. It just did not fit within the 12-nerve curriculum. And anyway, all five senses were accounted for by the other cranial nerves. How important could this little nerve be?

It would have been easier to overlook this inconvenient discovery if nerve zero were present only in sharks. But over the next century anatomists found the wispy nerve springing from the brain just in front of the olfactory nerve in almost all vertebrates (animals with backbones). To their chagrin, they found the nerve in humans, too, in 1913. Usually it is ripped away during dissection when the tough membranes that wrap the brain are peeled off, but if one knows where to look and is especially careful, the little nerve is always there. What is its purpose?

Indications are that people do exchange such secret pheromone messages.

One clue comes from how it is connected in the brain. Like the olfactory nerve, nerve zero sends its endings to the nose. Perhaps, some researchers argue, this nerve is simply a frayed strand of the olfactory nerve and not a separate cranial nerve at all. The dead pilot whale, my colleagues and I realized, was a perfect opportunity to examine that notion by looking directly to an example from nature.

Whales and dolphins are unique in having a blowhole on the top of their head. Whales evolved from aquatic mammals that breathed through nostrils in the front of the face. Over the course of millions of years of evolution, the nostrils gradually migrated to the top of their head. In the process, whales and dolphins gave up the sense of smell, and they lost their olfactory nerve. We realized that if nerve zero were also involved in the sense of smell—as just a twig branching off of the olfactory nerve—it, too, would have been abandoned in the evolutionary exchange of nostrils for blowhole. But if, as we suspected, nerve zero did something else, it might still be present in whales.

Before I relate the results of our autopsy, you must have a look at some of the evidence that raised our suspicions that nerve zero connects the sense of smell to sex.

Smell and Pheromones

Smell is the most ancient of all the senses—even the lowly bacterium must discern the difference between nutritious and noxious substances by sniffing (detecting chemicals in) its environs. Humans, who have a weak sense of smell compared with most mammals, nonetheless have 347 different types of sensory neurons in the olfactory epithelium, where cells for smell reside in the nose. Each one detects a different type of odor, and all the varied aromas and stenches we know result from mixtures of responses of these 347 types of receptor cells. In comparison, every color we see results from signal combinations of

THE AUTHOR

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only three types of sensory neurons in the retina (red-, green- or blue-sensitive cones), vision's sensing layer at the back of the eyes.

Animals rely heavily on the sense of smell and other nonverbal cues for communication. From frenzied June beetles to tomcats pursuing a queen in heat, pheromones are important for selecting mates and stimulating reproduction throughout the animal kingdom. A stallion curls its upper lip and inhales deeply to snuffle pheromones from a mare in heat, a behavior called flehming. Many animals also rely on the sense of smell to determine sex, social rank, territories, reproductive status and even identity of specific individuals, such as their own mates or offspring.

In humans, mate selection and sexual reproduction are far more complex, but there are indications that people do exchange such secret pheromone messages. Pheromones differ in two important ways from the chemicals that excite our sense of smell. For a smell to waft a distance from its source, the odor-producing molecules must be very small and volatile (able to float great distances in the air). Not so for pheromones, which can be large molecules passed between the noses of individuals during intimate contact, such as kissing.

Second, not all pheromones have an odor. If pheromones were to excite nerve endings that convey their signals directly to brain regions controlling sexual reproduction, bypassing the cerebral cortex where consciousness arises, they could act like an unseen olfactory cupid—putting a romantic twinkle in the eye of a certain member of the opposite sex—and we would never know it.

Pilot whale brains lost the olfactory nerve during evolution but retained nerve zero—an important clue to its function.

As it turns out, nerve zero's connections in the brain leave open that very possibility. To explain how requires a more detailed look at the circuitry for the sense of smell and for a special structure in the nose of many animals that detects pheromones, called the vomeronasal organ.

The olfactory nerve connects sense cells in our nose to the olfactory bulb inside our skull. This neural bulb is a massive relay point containing a nest of synapses. Raw incoming sensory information from the 347 kinds of odor receptors is first sorted here, then processed to analyze and discriminate among the universe of odors. The signals next pass to the olfactory cortex for finer discrimination and conscious perception of the odor.

For many animals that rely on pheromones for sexual communication, the key place for sensing these chemicals is a specialized area inside the vomeronasal organ. This organ, in turn, is connected to a tiny "accessory" olfactory bulb, next to the main olfactory bulb involved in the sense of smell. From there, nerves connect to areas of the brain involved in sexual arousal (such as the amygdala) rather than to the olfactory cortex. In rodents, for example, stimulating the vomeronasal organ with pheromones can release a flood of sex hormones into the blood.

Acting through the vomeronasal organ, pheromones influence the frequency of estrus and stimulate sexual behavior and ovulation in animals. The wrong pheromones can even terminate a pregnancy. In 1959 Hilda M. Bruce of the National Institute for Medical Research in London reported that an embryo will not implant in the uterus of a recently mated female mouse if she is exposed to the smell of urine from an unfamiliar male. Instead the embryo will be aborted, and the female will return to estrus. In contrast, the smell of urine from her mate does not prevent implantation and pregnancy.

In research published in 2006, Nobel laureate Linda Buck and her colleague Stephen Liberles, both then at the Fred Hutchinson Cancer Research Center in Seattle, identified 15 members of a new

Pheromones could act like an unseen olfactory cupid—putting a romantic twinkle in the eye of a mate.

DAVID A. NORTHCOTT *Corbis*

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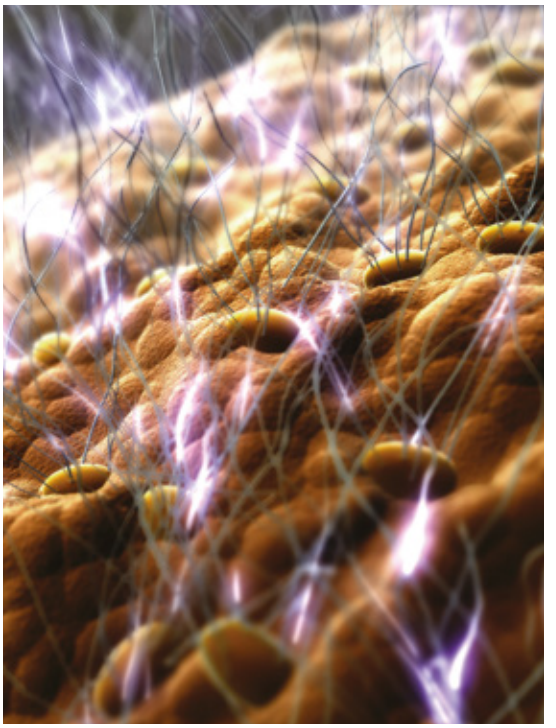
family of receptor proteins. These receptors, found in the mouse nose, exist on the surface of sense cells that detect pheromones, lending credence to the idea of a separate pathway for pheromones in mammals. These cells are different from the receptors that detect odors. Each of the TAARs (trace amine-associated receptors) responds selectively to specific nitrogen-containing molecules in mouse urine. The concentration of one of these chemicals increases in mouse—and human—urine under the stresses associated with mating behavior, such as those involving dominance and submission. Two of the TAARs are excited by compounds found exclusively in the urine of male mice, but only after puberty, also suggesting a sex link. Incidentally, behavioral researchers had previously identified one of these compounds and found that it accelerated the onset of puberty in female mice.

We now have an understanding of pheromones in mice that extends from molecules to sexual behavior, but what about pheromones in humans? Intriguingly, Buck found that humans have the genes to make at least six of the same pheromone receptors present in mice.

Nerve Zero's Role

Although some scientists claim to have detected an operational vomeronasal organ in humans as well, most believe that it appears to be vestigial. As is the case with gill slits, we possess vomeronasal organs only during our fetal lives, after which they atrophy. So if pheromones are sending sexual signals to human brains, they are not relying on the vomeronasal organ to relay them. Instead nerve zero might be stepping into the breach.

Consider the following anatomical features of nerve zero. Like its olfactory cousin, nerve zero has its endings in the nasal cavity, but remember that it sends its nerve fibers to the hot-button sex regions of the brain: the medial and lateral septal nuclei and preoptic areas. These regions of the brain are concerned with the "nuts and bolts" of reproduction. They control release of sex hormones and other irresistible urges such as thirst and hunger. The septal nucleus can act on and be influenced by the amygdala, hippocampus and hypothalamus. Damage to the septal nuclei causes behavioral changes in sexual behavior, feeding, drinking and rage reactions. Thus, in connecting the nose to the reproductive centers of the brain, nerve zero completely bypasses the olfactory bulb.



THIERRY BERROD *Science Source*

Vomeronasal organ in a mouse transmits sexual signals to the brain. In humans the organ is vestigial. Could nerve zero provide a similar function?

Cutting the olfactory nerve or removing the vomeronasal organ will disrupt normal mating behavior in rodents, suggesting that the olfactory nerve transmits pheromone messages from the vomeronasal organ. But in the past two decades researchers have come to understand that nerve zero *also* sends fibers to the vomeronasal organ—and that nerve zero's fibers run extremely close to the fibers of the olfactory nerve. As a result, in experiments in which the olfactory nerve was deliberately severed, investigators may have inadvertently cut through nerve zero as well.

In 1987 neuroscientist Celeste Wirsig, then at Baylor College of Medicine, carefully severed the nerve zero of male hamsters, leaving the olfactory nerve unscathed (as shown by the fact that hamsters with a severed nerve zero could find a hidden cookie just as fast as control animals could). The hamsters with a severed nerve zero failed to mate.

Similarly, in 1980 neuroscientists observed that electrically stimulating the olfactory nerve could trigger sexual responses in fish and other animals. But could this sexual behavior actually result from a stimulated nerve zero, which runs close to the olfactory nerve for most of its length? Neuroanatomists R. Glenn Northcutt, then at the University of Michigan (now at the University of California, San Diego), and Demski, then at Kentucky (now at the New College of Florida), suspected as much. They also knew that on their way to the brain, some fibers in nerve zero took an unexpected side trip and sent branches to the retinas of the eyes. This may seem odd until you realize that for most plants and animals, reproduction is seasonal—and day length is the most accurate way to gauge time of year. Many scientists suspect that a nerve involved in mating and reproduction might also connect to the retina to keep a constant check on the calendar.

Regardless of function, this place was where nerve zero and the olfactory nerve parted company, so Northcutt and Demski were able to apply a mild electric shock to goldfish nerve zero fibers in this site without stimulating the olfactory nerve at the same time. When they did, the male goldfish responded instantly by releasing sperm.

Therefore, in addition to the anatomical evidence that nerve zero connected the nose to parts of the brain controlling sexual reproduction, strong

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physiological evidence now existed that—in fish at least—nerve zero might be a sensory system for responding to sex pheromones and regulating reproductive behavior. Another lead pointing to a sexual role for nerve zero would come from my own research, again on a creature from the sea.

In 1985, while studying nerve zero of a stingray using the electron microscope, I saw something peculiar: many of its axons (nerve fibers) were stuffed with what looked like minuscule black spheres. They turned out to be peptide hormones packed tightly together like pellets in a shotgun shell. And at the tips of some of these nerves, I observed the release of these hormones and their uptake by tiny blood vessels—suggesting that nerve zero may in fact be a neurosecretory organ, meaning that it regulates reproduction by releasing hormones in much the same way as the pituitary gland does. This new clue that the terminal nerve released sex hormones, together with the knowledge that it connected the nose to parts of the brain controlling sexual reproduction, triangulated on one conclusion: pheromones.

Yet skeptical scientists have credited arousal exclusively to the olfactory nerve, still arguing that nerve zero is not a separate cranial nerve at all but simply a frayed strand of the olfactory nerve. So when Demski and I heard that a pilot whale had just died at the San Diego Naval Base, we jumped at the chance to examine it. This animal could show us whether nerve zero was truly autonomous and might even help illuminate its function.

Whale of a Find

Back in the lab at Scripps, Demski reached into a plastic bucket with gloved hands and withdrew the pilot whale's brain that we had removed from the immense carcass. It was about the size of a soccer ball and resembled a human brain, except that its cerebral cortex had tighter and more numerous convolutions—almost kinky in comparison to the wavy folds of a human cortex.

After turning over the whale brain for a look at its underside, we were

CHEMICAL MESSAGES

What is it about sexual attraction that can instantly draw two people together? Could pheromones be a factor for human couples, as they are for other animals? Research on molecules that protect us from infections offers intriguing clues.

In many animals, the nose can determine sex and reproductive status by sensing trace hormones and other compounds in urine and sweat. A different class of molecules provides information about the individual identity of a mate. Such macromolecules, called major histocompatibility complex (MHC) proteins, sit on the surface of cells to allow the immune system to distinguish the body's own cells from foreign ones.

Here is how it works. MHC molecules are huge proteins equipped with bird beak–like appendages that snatch small protein fragments inside cells and poke them through the cell membrane for guard patrols called T cells to inspect. If the protein fragments are foreign, the immune system attacks.

Some studies suggest that people can discern whether someone has different MHC genes. Biologist Claus Wedekind, then at the University of Bern in Switzerland, reported in the mid-1990s that in one study women preferred the odor of T-shirts worn two nights by men who had different MHC genes from their own; men had the same ability to distinguish MHC genes by smell. In a 1997 study geneticist Carole Ober of the University of Chicago and her colleagues reported that people avoid mating with individuals carrying the type of MHC genes most similar to those of their own mothers.

It makes good evolutionary sense to mate with someone who has a different set of MHC genes, because doing so increases the arsenal of immune system genes in your children and thus allows them to better resist infection. It is also biologically important to diminish sexual arousal toward one's own family members, who are most likely to share your variety of MHC genes. The Wedekind and Ober studies suggest that an individual's odor is affected by the particular variety of MHC genes he or she has. This effect may come about because differences in an individual's immune system alter the body's bacterial flora and, in turn, the resulting odors created by the breakdown of sweat and apocrine gland secretions by these bacteria. But would nature leave such a vital process as mate selection under the control of microbes, which can change with infections and other environmental influences?

As it turns out, it is not the MHC protein itself that is the pheromone. Research indicates that it is the small protein fragment clutched in the jaws of the MHC molecule. In 2004 neurobiologist Trese Leinders-Zufall, now at the Saarland University Medical Center in Germany, and her colleagues found that when synthetic protein fragments that are more readily picked up by classes of MHC proteins in unfamiliar mice were added to the urine of the female mouse's mate, pregnancy was blocked just as if she had been exposed to urine from an unfamiliar male mouse. —*R.D.F.*

Stallion snuffles pheromones from a mare in heat.

KIT HOUGHTON *Corbis*

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struck by the strangeness of seeing a mammalian brain devoid of its olfactory nerves. (Remember that whales lost their sense of smell in exchange for blowholes.) Demski carefully peeled away the membranes from the area in which we expected to find a pair of nerve zeros, assuming they had not been lost along with the olfactory nerves. With the surprise of unwrapping a present, we found them: two slender white nerves headed toward the whale's blowhole.

Our postmortem on the pilot whale had proved that nerve zero was a distinct neural entity, not just a fragment of the olfactory nerve. And for whales and dolphins, which had sacrificed their sense of smell and the olfactory nerves that made it possible, whatever nerve zero did was too precious to survival for evolution to abandon.

Despite the intriguing findings, nerve zero's role in the sexual behavior of humans remains unclear. Research in mice has revealed the presence of certain sensory neurons that are not associated with the vomeronasal organ but that respond to pheromone stimulation. So even without a functioning vomeronasal organ, our noses may nonetheless contain sensory neurons capable of responding to pheromones.

How much of this labor is split between the olfactory nerve and nerve zero is not yet worked out. Obviously, nerve zero is doing something different with the information it is receiving from the nose because it does not connect to the olfactory bulb where smells are analyzed. Moreover, it connects to parts of the brain controlling reproduction, and it releases a powerful sex hormone (GnRH) into the blood.

Nerve zero develops very early in embryos, and studies show that all the neurons in the forebrain that produce GnRH use the fetal nerve zero as a pathway to migrate along to find their proper place in the brain. When this embryonic pathway is disrupted, Kallmann's syndrome is the result. This disorder not only impairs people's sense of smell, it leaves them unable to mature sexually beyond puberty. Undoubtedly, nerve zero has other functions in addition to reproduction—most cranial nerves transmit sensory and motor (related to body movement) traffic. Electrical impulses have been detected traveling out from the brain through nerve zero, but what the outgoing messages do is puzzling.

Nerve impulses travel out from the brain through nerve zero, but their purpose is unknown.

One of the most intriguing things about the story of nerve zero is the suggestion that signals in the environment control our brain and behavior. This notion clashes with our passionate belief in free will, but the evidence continues to mount.

A study by Denise Chen, now at Baylor College, and her colleagues found that people performed better on cognitive tests while sniffing sweat collected from individuals who had been watching a scary movie than they did while smelling the sweat of people who had been watching a happy movie. The test takers said they could not tell the difference between the two types of sweat, but they were more cautious and accurate while inhaling the sweat of fearful moviegoers. In many animals stress and fear produce lifesaving chemical warning signals—humans, it seems, are no different.

Functional magnetic resonance imaging is also providing a fascinating window into pheromone stimulation of the human brain. A study by Valerie Treyer and her colleagues at University Hospital Zurich revealed that an odorless pheromone extracted from swine sweat (5a-Androst-16-en-3-one) stimulates neural activity in the same "pleasure/reward" region of the human brain activated by smelling roses—something to keep in mind the next time your guy shows up with an expectant smile and a fist full of flowers.

Many animals have specialized scent glands for releasing pheromones, but so do people. The dark area surrounding a mother's nipple, called the areola, warms suddenly at the sound of a crying infant, and pheromones are released from the bumpy skin glands that ring the area. A team led by Benoist Schaal, now at the University of Burgundy in Dijon, France, found that these pheromones speed the time it takes a newborn infant to locate the breast and begin suckling. Infants of mothers who are blessed with more of these scent glands latch on faster and gain weight quicker than infants born to women with fewer glands.

Nerve zero undermines not only our confidence in free will but also our faith in our own senses. Research on animals shows that impulses from nerve zero change how the environment is perceived. Neuropeptides released from the endings of nerve zero in the nose modify the sense of smell by adjusting the sensitivity of olfactory neurons. In the same way, fibers from nerve zero that enter the retina of a fish's eye alter processing of visual information in response to olfactory signals stimulating the nerve. In fish, at least, nerve zero may provide a biological basis for the adage that "love is blind." M

MORE TO EXPLORE

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BONOBO SEX AND SOCIETY

Inclined toward gender equality, this close relative of humans substitutes sex for aggression

BY **Frans B. M. de Waal**

At a juncture in history during which women are seeking equality with men, science arrives with a belated gift to the feminist movement. Male-biased evolutionary scenarios—Man the Hunter, Man the Toolmaker, and so on—are being challenged by the discovery that females play a central, perhaps even dominant, role in the social life of one of our nearest relatives. In the past three decades many strands of knowledge have come together concerning a relatively unknown ape with an unorthodox repertoire of behavior: the bonobo.

The bonobo is one of the last large mammals to be found by science. The creature was discovered in 1929 in a Belgian colonial museum, far from its lush African habitat. A German anatomist, Ernst Schwarz, was scrutinizing a skull that had been ascribed to a juvenile chimpanzee because of its small size, when he realized that it belonged to an adult. Schwarz declared that he had stumbled on a new subspecies of chimpanzee. But soon the animal was assigned the status of an entirely distinct species within the same genus as the chimpanzee, *Pan*.

The bonobo was officially classified as *Pan paniscus*, or the diminutive *Pan*.

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FRANS LANTING *Corbis*

But I believe a different label might have been selected had the discoverers known then what we know now. The old taxonomic name of the chimpanzee, *P. satyrus*—which refers to the myth of apes as lustful satyrs—would have been perfect for the bonobo.

The species is best characterized as female-centered and egalitarian and as one that substitutes sex for aggression. Whereas in most other species sexual behavior is a fairly distinct category, in the bonobo it is part and parcel of social relations—and not just between males and females. Bonobos engage in sex in virtually every partner combination (although such contact among close family members may be suppressed). Sexual interactions occur more often among bonobos than among other primates, but the bonobo's rate of reproduction in the wild is about the same as that of the chimpanzee. A female gives birth to a single infant at intervals of between five and six years. So bonobos share at least one very important characteristic with our own species, namely, a partial separation between sex and reproduction.

A Near Relative

The bonobo shares more than 98 percent of our genetic profile, making it as close to a human as, say, a fox is to a dog. The split between the human line of ancestry and the line of the chimpanzee and the bonobo is believed to have occurred a mere eight million years ago. The subsequent divergence of the chimpanzee and the bonobo lines came much later, perhaps prompted by the chimpanzee's need to adapt to relatively open, dry habitats.

In contrast, bonobos probably never left the protection of the trees. Their present range lies in humid forests south of the Congo River, where perhaps fewer than 10,000 bonobos survive. (Given the species' slow rate of reproduction, the rapid destruction of its tropical habitat and the political instability of Central Africa, there is reason for much concern about its future.)

If this evolutionary scenario is true, the bonobo may have undergone less transformation than either humans or chimpanzees. In the 1930s Harold J. Coolidge—the American anatomist who gave the bonobo its eventual taxonomic status—suggested that the animal might be most similar to the common ancestor of all three modern species, because its anatomy is less specialized than is the chimpanzee's. When bonobos stand or walk upright, they look as if they stepped straight out of an artist's impression of early hominids.

Not too long ago the savanna baboon was regarded as the best living model of the human ancestor. That primate is adapted to the kinds of ecological conditions that prehumans may have faced after descending from the trees. But in the late 1970s chimpanzees, which are much more closely related to humans, became the model of choice. Traits that are observed in chimpanzees—including cooperative hunting, food sharing, tool use and primitive warfare—were absent or not as developed in baboons. In the laboratory the apes have been able to learn sign language and to recognize themselves in a mirror, a sign of self-awareness not yet demonstrated in monkeys.

Although selecting the chimpanzee as the touchstone of hominid evolution represented a great improvement, at least one aspect of the former model did not need to be revised: male superiority remained the natural state of affairs. In both baboons and chimpanzees, males are conspicuously dominant over females; they reign supremely and often brutally. It is highly unusual for a fully grown male chimpanzee to be dominated by any female.

Enter the bonobo. Despite their common name—the pygmy chimpanzee—bonobos cannot be distinguished from the chimpanzee by size. Adult males of the smallest subspecies of chimpanzee weigh some 43 kilograms (95 pounds) and females 33 kilograms (73 pounds), about the same as bonobos. Although female bonobos are much smaller than the males, they seem to rule.

Graceful Apes

In physique, a bonobo is as different from a chimpanzee as a Concorde is from

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a Boeing 747. I do not wish to offend any chimpanzees, but bonobos have more style. The bonobo, with its long legs and small head atop narrow shoulders, has a more gracile build than a chimpanzee does. Bonobo lips are reddish in a black face, the ears small and the nostrils almost as wide as a gorilla's. These primates also have a flatter, more open face with a higher forehead than the chimpanzee's and—to top it all off—an attractive coiffure with long, fine, black hair neatly parted in the middle.

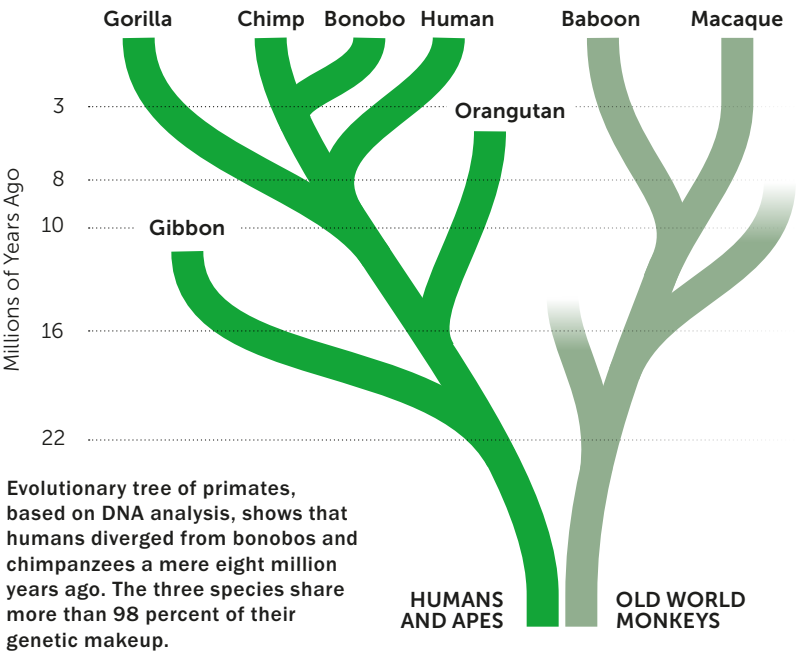
Like chimpanzees, female bonobos nurse and carry around their young for up to five years. By the age of seven the offspring reach adolescence. Wild females give birth for the first time at 13 or 14 years of age, becoming full grown by about 15. A bonobo's longevity is unknown, but judging by the chimpanzee it may be older than 40 in the wild and close to 60 in captivity.

Fruit is central to the diets of both wild bonobos and chimpanzees. The former supplement with more pith from herbaceous plants, and the latter add meat. The bonobo diet contains relatively little animal protein, but bonobos do eat invertebrates and have even been seen to capture and consume monkeys. Unlike humans and chimpanzees, however, hunting in bonobos is as much a female as a male affair.

Whereas chimpanzees use a rich array of strategies to obtain foods—from cracking nuts with stone tools to fishing for ants and termites with sticks—tool use in wild bonobos seems undeveloped. (Captive bonobos use tools skillfully.) Apparently as intelligent as chimpanzees, bonobos have, however, a far more sensitive temperament. During a World War II bombing of Hellabrunn, Germany, the bonobos in a nearby zoo all died of fright; the chimpanzees were unaffected.

Bonobos are also imaginative in play. Juveniles like to make funny faces, sometimes in long solitary pantomimes and at other times while tickling one another. Bonobos are, however, more controlled in expressing their emotions—whether it be joy, sorrow, excitement or anger—than are the extroverted chimpanzees. Male chimpanzees often engage in spectacular charging displays in which they show off their strength: throwing rocks, breaking branches and uprooting small trees in the process. They keep up these noisy performances for many minutes, during which most other members of the group wisely stay out of their way. Male bonobos, on the other hand, usually limit displays to a brief run while dragging a few branches.

Both primates signal emotions and intentions through facial expressions and hand gestures, many of which are also present in the nonverbal communication of humans. For example, bonobos will beg by stretching out an open hand (or, sometimes, a foot) to a possessor of food and will pout their lips and make whimpering sounds if the effort is unsuccessful. But bonobos make different sounds than chimpanzees do. The renowned low-pitched, extended "huuu-huuu" pant-hooting of the latter contrasts with the rather sharp, high-pitched barking sounds of bonobos.



Evolutionary tree of primates, based on DNA analysis, shows that humans diverged from bonobos and chimpanzees a mere eight million years ago. The three species share more than 98 percent of their genetic makeup.

FAST FACTS
KEEPING THE PEACE

1. The bonobo, an ape that is closely related to humans, engages frequently in a variety of sexual activities—and with a diversity of partners.
2. Bonobos live in female-centered societies and appear to use sex as a way to defuse tension and restore harmony.
3. Studies of bonobos may help us understand the role that sex plays in human society.

Love, Not War

My own interest in bonobos came not from an inherent fascination with their charms but from research on aggressive behavior in primates. I was particularly intrigued with the aftermath of conflict. After two chimpanzees have fought, for instance, they may come together for a hug and mouth-to-mouth kiss. Assuming that such reunions serve to restore peace and harmony, I labeled them reconciliations.

Any species that combines close bonds with a potential for conflict needs such conciliatory mechanisms. Thinking how much faster marriages would break up if people had no way of compensating for hurting one another, I set out to investigate such mechanisms in several primates, including bonobos. Although I expected to see peacemaking in these apes, too, I was little prepared for the form it would take.

For my study, which began in 1983, I chose the San Diego Zoo. At the time, it housed the world's largest captive bono-

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bo colony—10 members divided into three groups. I spent entire days in front of the enclosure with a video camera, which was switched on at feeding time. As soon as a caretaker approached the enclosure with food, the males would develop erections. Even before the food was thrown into the area, the bonobos would be inviting each other for sex: males would invite females, and females would invite males and other females.

Sex, it turned out, is the key to the social life of the bonobo. The first suggestion that the sexual behavior of bonobos is different had come from observations at European zoos. Wrapping their findings in Latin, primatologists Eduard Tratz and Heinz Heck reported in 1954 that the chimpanzees at Hellabrunn mated *more canum* (like dogs) and bonobos *more hominum* (like people). In those days, face-to-face copulation was considered uniquely human, a cultural innovation that needed to be taught to preliterate people (hence the term "missionary position"). These early studies, written in German, were ignored by the international scientific establishment. The bonobo's humanlike sexuality needed to be rediscovered in the 1970s before it became accepted as characteristic of the species.

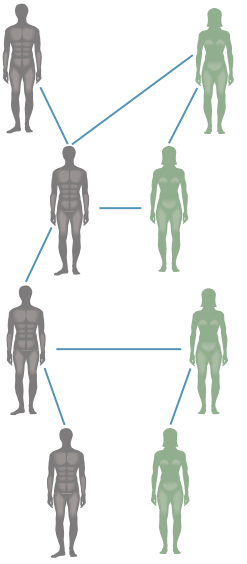
Bonobos become sexually aroused remarkably easily, and they express this excitement in a variety of mounting positions and genital contacts. Although chimpanzees virtually never adopt face-to-face positions, bonobos do so in one out of three copulations in the wild. Furthermore, the frontal orientation of the bonobo vulva and clitoris strongly suggests that the female genitalia are adapted for this position.

Another similarity with humans is increased female sexual receptivity. The tumescent phase of the female's genitals, resulting in a pink swelling that signals willingness to mate, covers a much longer part of estrus in bonobos than in chimpanzees. Instead of a few days out of her cycle, the female bonobo is almost continuously sexually attractive and active [*see illustration on page 48*].

Perhaps the bonobo's most typical sexual pattern, undocumented in any

OPPOSITE PAGE AND THIS PAGE: LAURIE GRACE

SOCIAL ORGANIZATION OF THE HOMINOIDS



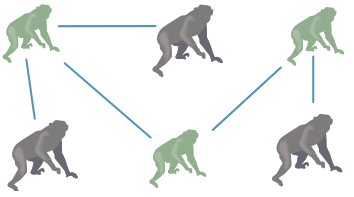
GIBBON

Male (*gray*) and female (*green*) gibbons establish monogamous, egalitarian relations, and each couple has an exclusive territory.

HUMAN

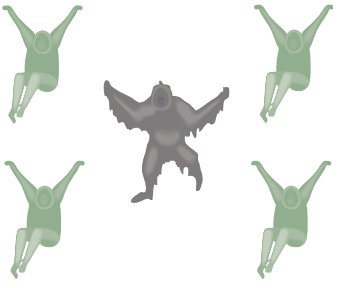
Human society is the most diverse among the primates. Males unite for cooperative ventures, whereas females also bond with those of their own sex. Monogamy, polygamy and polyandry are all in evidence.

BONOBO



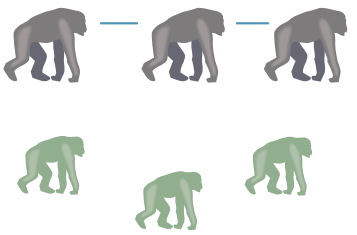
Bonobo communities are peace-loving and generally egalitarian. The strongest social bonds (*blue lines*) are those among females, although females also bond with males. The status of a male depends on the position of his mother, to whom he remains bonded for her entire life.

ORANGUTANS



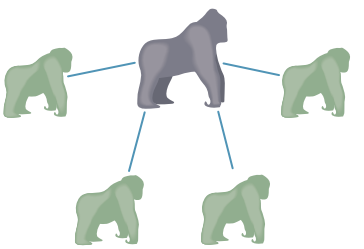
Orangutans live solitary lives with little bonding in evidence. Male orangutans are intolerant of one another. In his prime, a single male establishes a large territory, within which live several females. Each female has her own, separate home range.

CHIMPANZEE



In chimpanzee groups the strongest bonds are established between the males to hunt and to protect their shared territory. The females live in overlapping home ranges within this territory but are not strongly bonded to other females or to any one male.

GORILLA



The social organization of gorillas provides a clear example of polygamy. Usually a single male maintains a range for his family unit, which contains several females. The strongest bonds are those between the male and his females.

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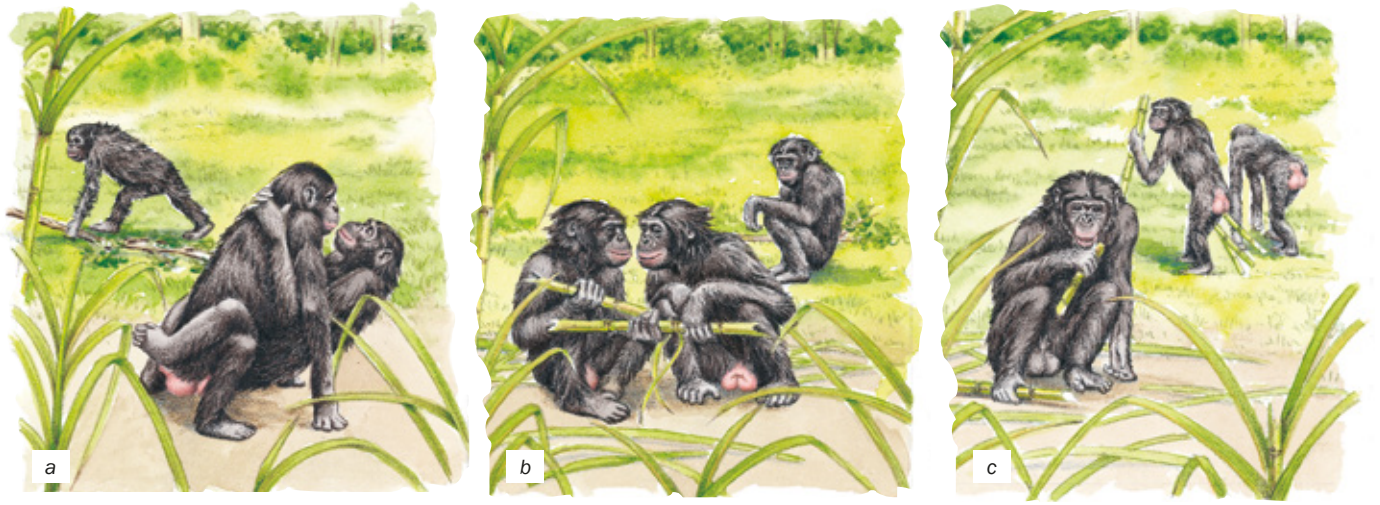

Dominance by bonding is evinced by female bonobos, who engage in genito-genital (GG) rubbing before eating sugarcane (*a*); meanwhile a bigger male displays to no avail. The females then share the food without competition (*b*). Only when they leave can the male get to the sugarcane (*c*). In male-dominated chimpanzee society the male eats first (*d*), while the females wait at a safe distance. After he leaves (*e*), carrying as many bananas as he can, the dominant female gets what is left (*f*). Small amounts of sugarcane and bananas are provided at some research sites in the Democratic Republic of the Congo (formerly Zaire).

other primate, is genito-genital rubbing (or GG rubbing) between adult females. One female facing another clings with arms and legs to a partner that, standing on both hands and feet, lifts her off the ground. The two females then rub their genital swellings laterally together, emitting grins and squeals that probably reflect orgasmic experiences. (Lab experiments on stump-tailed macaques have demonstrated that women are not the only female primates capable of physiological orgasm.)

Male bonobos, too, may engage in pseudocopulation but generally perform a variation. Standing back to back, one male briefly rubs his scrotum against the buttocks of another. They also practice penis fencing, in which two males hang face to face from a branch while rubbing their erect penises together.

The diversity of erotic contacts in bonobos includes sporadic oral sex, genital massages and intense tongue-kissing. Lest this leave the impression of a pathologically oversexed species, I must add, based on hundreds of hours of watching bonobos, that their sexual activity is rather casual and relaxed. It appears to be a completely natural part of their group life. Like people, bonobos engage in sex only occasionally, not continuously. Furthermore, with the average copulation lasting 13 seconds, sexual contact in bonobos is quick by human standards.

That sex is connected to feeding, and even appears to make food sharing possible, has been observed not only in zoos but also in the wild. Nancy Thompson-Handler, then at Stony Brook University, saw bonobos in the Lomako Forest of the Democratic Republic of the Congo (formerly Zaire) engage in sex after they had entered trees loaded with ripe figs or when one bonobo had captured a prey animal. The flurry of sexual contacts would last for five to 10 minutes, after which the apes would settle down to eat.

One explanation for the sexual activity at feeding time could be that excitement over food translates into sexual arousal. This idea may be partly true. Yet another motivation is probably the real cause: competition. There are two reasons to believe sexual activity is the bonobo's answer to avoiding conflict.

First, anything, not just food, that arouses the interest of more than one bonobo at a time tends to result in sexual contact. If two bonobos approach a cardboard box thrown into their enclosure, they will briefly mount each other before playing with the box. Such situations lead to squabbles in most other species. But bonobos are quite tolerant, perhaps because they use sex to divert attention and to defuse tension.

Second, bonobo sex often occurs in aggressive contexts unrelated to food. A jealous male might chase another away from a female, after which the two males reunite and engage in scrotal rubbing. Or after a female hits a juvenile, the latter's mother may lunge at the aggressor, an action that is immediately followed by genital rubbing between the two adults.

I once observed a young male, Kako, inadvertently blocking an older, female juvenile, Leslie, from moving along a branch. First, Leslie pushed him; Kako, who was not very confident in trees, tightened his grip, grinning nervously.

THE AUTHOR

FRANS B. M. DE WAAL was trained as an ethologist in the European tradition, receiving his Ph.D. in 1977 from the University of Utrecht in the Netherlands. After a six-year study of the chimpanzee colony at the Arnhem Zoo, he moved to the U.S. in 1981 to work on other primate species, including bonobos. He is now director of Living Links at the Yerkes National Primate Research Center in Atlanta and C. H. Candler Professor of Primate Behavior at Emory University.

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CHIMPANZEE

d

e

f

Next Leslie gnawed on one of his hands, presumably to loosen his grasp. Kako uttered a sharp peep and stayed put. Then Leslie rubbed her vulva against his shoulder. This gesture calmed Kako, and he moved along the branch. It seemed that Leslie had been very close to using force but instead had reassured both herself and Kako with sexual contact.

During reconciliations, bonobos use the same sexual repertoire as they do during feeding time. Based on an analysis of many such incidents, my study yielded the first solid evidence for sexual behavior as a mechanism to overcome aggression. Not that this function is absent in other animals—or in humans, for that matter—but the art of sexual reconciliation may well have reached its evolutionary peak in the bonobo. For these animals, sexual behavior is indistinguishable from social behavior. Given its peacemaking and appeasement functions, it is not surprising that sex among bonobos occurs in so many different partner combinations, including between juveniles and adults. The need for peaceful coexistence is obviously not restricted to adult heterosexual pairs.

Female Alliance

Apart from maintaining harmony, sex is also involved in creating the singular social structure of the bonobo. This use of sex becomes clear when studying bonobos in the wild. Field research on bonobos started only in the mid-1970s, a decade after the most important studies on wild chimpanzees had begun. In terms of continuity and invested (wo)manpower, the chimpanzee projects of Jane Goodall and the late Toshisada Nishida, both in Tanzania, are unparalleled. But bonobo research by Takayoshi Kano and others of Kyoto University began to show similar payoffs after two decades at Wamba in the Democratic Republic of the Congo.

Both bonobos and chimpanzees live in so-called fission-fusion societies. The apes move alone or in small parties of a few individuals at a time, the composition of which changes constantly. Several bonobos traveling together in the morning might meet another group in the forest, whereupon one individual from the first group wanders off with others from the second group, while those left behind forage together. All associations, except the one between mother and dependent offspring, are of a temporary character.

Initially this flexibility baffled investigators, making them wonder if these apes formed any social groups with stable membership. After years of documenting the travels of chimpanzees in the Mahale Mountains, Nishida first reported that they form large communities: all members of one community mix freely in ever changing parties, but members of different communities never gather. Later, Goodall added territoriality to this picture: not only do communities not mix, but males of different chimpanzee communities engage in lethal battles.

In both bonobos and chimpanzees, males stay in their natal group, whereas females tend to migrate during adolescence. As a result, the senior males of a chimpanzee or bonobo group have known all junior males since birth, and all junior males have grown up together. Females, on the other hand, transfer to an unfamiliar and often hostile group where they may know no one. A chief difference between chimpanzee and bonobo societies is the way in which young females integrate into their new community.

On arrival in another community, young bonobo females at Wamba single out one or two senior resident females for special attention, using frequent GG rubbing and grooming to establish a relation. If the residents reciprocate, close associations are set up, and the younger female gradually becomes accepted into the group. After producing her first offspring, the young female's position becomes more stable and central. Eventually the cycle repeats with younger immigrants, in turn, seeking a good relation with the now established female. Sex thus smooths the migrant's entrance into the community of females, which is much more close-knit in the bonobo than in the chimpanzee.

Bonobo males remain attached to their mothers all their lives, following them through the forest and being dependent on them for protection in aggressive encounters with other males. As a result, the highest-ranking males tend to be sons of important females.

SUZANNE BARNES

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What a contrast with chimpanzees! Male chimpanzees fight their own battles, often relying on the support of other males. Furthermore, adult male chimpanzees travel together in same-sex parties, grooming one another frequently. Males form a social hierarchy with high levels of both competition and association. Given the need to stick together against males of neighboring communities, their bonding is not surprising: failure to form a united front might result in the loss of lives and territory. The danger of being male is reflected in the adult sex ratio of chimpanzee populations, with considerably fewer males than females.

Serious conflict between bonobo groups has been witnessed in the field, but it seems rare. On the contrary, reports exist of peaceable mingling, including sex and grooming, between what appear to be different communities. If intergroup combat is indeed unusual, it may explain the lower rate of all-male associations. Rather than being male-bonded, bonobo society gives the impression of being female-bonded, with even adult males relying on their mothers instead of on other males. No wonder Kano calls mothers the "core" of bonobo society.

The bonding among female bonobos violates a fairly general rule, outlined by Harvard University anthropologist Richard W. Wrangham, that the sex that stays in the natal group develops the strongest mutual bonds. Bonding among male chimpanzees follows naturally because they remain in the community of their birth. The same is true for female kinship bonding in Old World monkeys, such as macaques and baboons, where males are the migratory sex.

Bonobos are unique in that the migratory sex, females, strongly bond with same-sex strangers later in life. In setting up an artificial sisterhood, bonobos can be said to be secondarily bonded. (Kinship bonds are said to be primary.) Although we know *how* this happens—through sexual contact and grooming—we do not yet know *why* bonobos and chimpanzees differ in this respect.

Bonobo society is not only female-centered but also appears to be female-dominated. Bonobo specialists, while long suspecting such a reality, had been reluctant to make the controversial claim. But in 1992, at the 14th Congress of the International Primatological Society in Strasbourg, investigators of both captive and wild bonobos presented data that left little doubt about the issue.

Amy R. Parish, now at the University of Southern California, reported on food competition in identical groups (one adult male and two adult females) of chimpanzees and bonobos at the Stuttgart Zoo. Honey was provided in a "termite hill" from which it could be extracted by dipping sticks into a small hole. As soon as honey was made available, the male chimpanzee would make a charging display through the enclosure and claim everything for himself. Only when his appetite was satisfied would he let the females fish for honey.

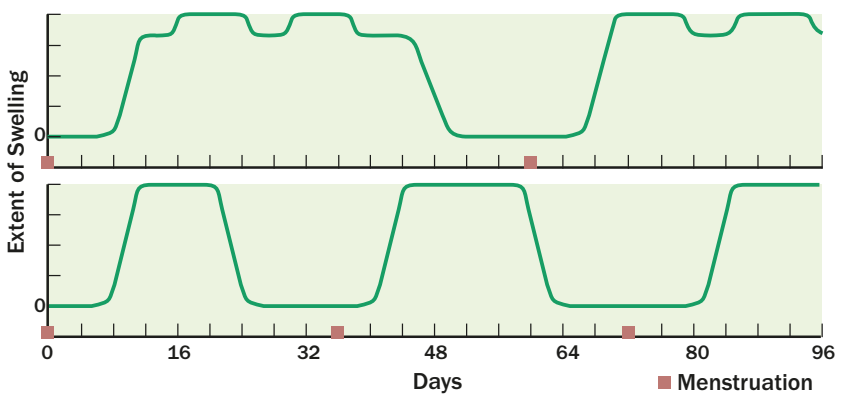
In the bonobo group, it was the females that approached the honey first. After having engaged in some GG rubbing, they would feed together, taking turns with virtually no competition among them. The male might make as many charging displays as he wanted; the females were not intimidated and ignored the commotion.

Observers at the Belgian animal park of Planckendael, which currently has the most naturalistic bonobo colony, reported similar findings. If a male bonobo tried to harass a female, all females would band together to chase him off. Because females appeared more successful in dominating males when they were together than on their own, their close association and frequent genital rubbing may represent an alliance. Females may bond so as to outcompete members of the individually stronger sex.

The fact that they manage to do so not only in captivity is evident from Kyoto zoologist Takeshi Furuichi's summary of the relation between the sexes at Wamba, where bonobos are enticed out of the forest with sugarcane. "Males usually appeared at the feeding site first, but they surrendered preferred positions when the females appeared. It seemed that males appeared first not because they were dominant, but because they had to feed before the arrival of females," Furuichi reported at Strasbourg.

Sex for Food

Occasionally, the role of sex in relation to food is taken one step further, bringing bonobos very close to humans in their behavior. It has been speculated by anthropologists—including C. Owen Lovejoy of Kent State University and Helen Fisher of Rutgers University—that sex is partially separated from reproduction in our species because it serves to cement mutually profitable relationships be-



Female receptivity for sex, manifested by swollen genitals, occupies a much larger proportion of the estrus cycle of bonobos (*top*) than of chimpanzees (*bottom*). The receptivity of bonobos continues through lactation. (In chimpanzees, it disappears.) This circumstance allows sex to play a large part in the social relations of bonobos. The graph was provided by Jeremy Dahl, then at the Yerkes National Primate Research Center.

LAURIE GRACE

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Behavior among bonobos is often reminiscent of that among humans. A female and an infant play (*top left*); a bonobo walks upright, using his hands to carry food (*top right*); two juveniles practice sex without penetration (*bottom left*); and a male and female have sex while facing each other (*bottom right*), a position once thought to be uniquely human.

FRANS LANTING *Corbis* (*top row* and *bottom left*); STEPHANIE MENG *Corbis* (*bottom right*)

tween men and women. The human female's capacity to mate throughout her cycle and her strong sex drive allow her to exchange sex for male commitment and paternal care, thus giving rise to the nuclear family.

This arrangement is thought to be favored by natural selection because it allows women to raise more offspring than they could if they were on their own. Although bonobos clearly do not establish the exclusive heterosexual bonds characteristic of our species, their behavior does fit important elements of this model. A female bonobo shows extended receptivity and uses sex to obtain a male's favors when—usually because of youth—she is too low in social status to dominate him.

At the San Diego Zoo, I observed that if the female Loretta was in a sexually attractive state, she would not hesitate to approach the adult male Vernon if he had food. Presenting herself, she would mate with him and make high-pitched food calls while taking over his entire bundle of branches and leaves. When Loretta had no genital swelling, she would wait until Vernon was ready to share. Primatologist Suehisa Kuroda, now at the University of Shiga Prefecture, reports similar exchanges at Wamba: "A young female approached a male, who was eating sugarcane. They copulated in short order, whereupon she took one of the two canes held by him and left."

Despite such quid pro quo, there are no indications that bonobos form humanlike nuclear families. The burden of raising offspring appears to rest entirely on the female's shoulders.

Human family life implies paternal investment, which is unlikely to develop unless males can be reasonably certain that they are caring for their own, not someone else's, offspring. Bonobo society lacks any such guarantee, but humans protect the integrity of their family units through all kinds of moral restrictions and taboos. Thus, although our species is characterized by an extraordinary interest in sex, there are no societies in which people engage in it at the drop of a hat (or a cardboard box, as the case may be). A sense of shame and a desire for domestic privacy are typical human concepts related to the evolution and cultural bolstering of the family.

Yet no degree of moralizing can make sex disappear from every realm of human life that does not relate to the nuclear family. The bonobo's behavioral peculiarities may help us understand the role of sex and may have serious implications for models of human society.

Just imagine that we had never heard of chimpanzees or baboons and had known bonobos first. We would at present most likely believe that early hominids lived in female-centered societies, in which sex served important social functions and in which warfare was rare or absent. In the end, perhaps the most successful reconstruction of our past will be based not on chimpanzees or even on bonobos but on a three-way comparison of chimpanzees, bonobos and humans. **M**

MORE TO EXPLORE

- **The Communicative Repertoire of Captive Bonobos (*Pan paniscus*) Compared to That of Chimpanzees.** Frans B. M. de Waal in *Behaviour,* Vol. 106, Nos. 3–4, pages 183–251; September 1988.
- **The Last Ape: Pygmy Chimpanzee Behavior and Ecology.** Takayoshi Kano. Stanford University Press, 1992.
- **Chimpanzee Cultures.** Richard W. Wrangham, W. C. McGrew, Frans B. M. de Waal and Paul Heltne. Harvard University Press, 1994.
- **Bonobo: The Forgotten Ape.** Frans B. M. de Waal, with photographs by Frans Lanting. University of California Press, 1996.
- **The Bonobos: Behavior, Ecology, and Conservation.** Edited by Takeshi Furuichi and Jo Thompson. Springer, 2008.

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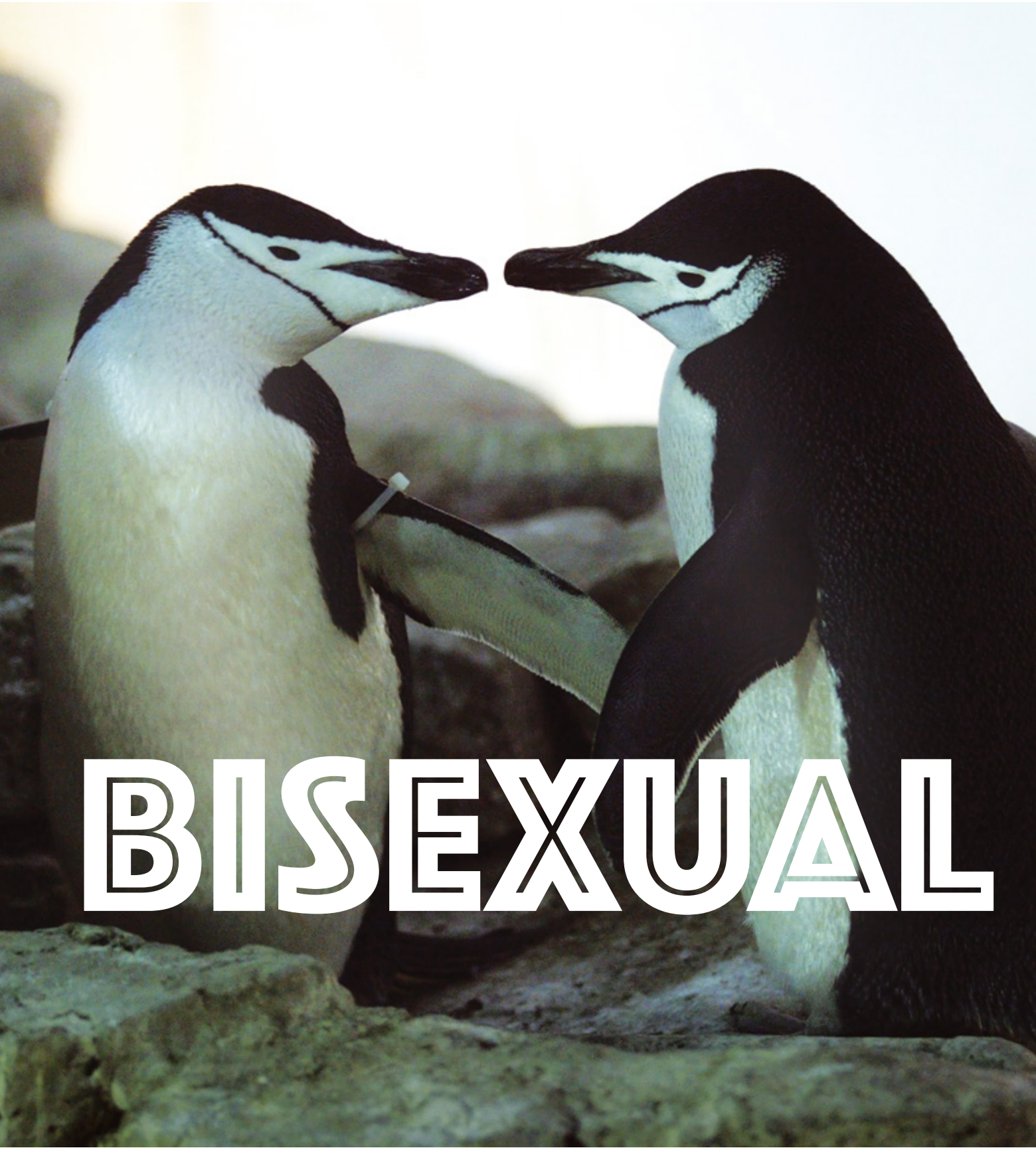

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THE SEXUAL BRAIN

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LEANINGS

Homosexual behavior is surprisingly common in the animal kingdom. It may be adaptive—helping animals to get along, maintain fecundity and protect their young

SPECIES

BY Emily V. Driscoll

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TWO PENGUINS NATIVE TO ANTARCTICA MET ONE SPRING DAY IN 1998 IN A TANK AT THE CENTRAL PARK ZOO IN MIDTOWN

Manhattan. They perched atop stones and took turns diving in and out of the clear water below. They entwined necks, called to each other and mated. They then built a nest together to prepare for an egg. But no egg was forthcoming: Roy and Silo were both male.

Robert Gramzay, a keeper at the zoo, watched the chinstrap penguin pair roll a rock into their nest and sit on it, according to newspaper reports. Gramzay found an egg from another pair of penguins that was having difficulty hatching it and slipped it into Roy and Silo's nest. Roy and Silo took turns warming the egg with their blubbery underbellies until, after 34 days, a female chick pecked her way into the world. Roy and Silo kept the gray, fuzzy chick warm and regurgitated food into her tiny black beak.

Like most animal species, penguins tend to pair with the opposite sex, for the obvious reason. But researchers are finding that same-sex couplings are surprisingly widespread in the animal kingdom. Roy and Silo belong to one of as many as 1,500 species of wild and captive animals that have been observed engaging in homosexual activity. Researchers have seen such same-sex goings-on in both male and female, old and young, and social and solitary creatures and on branches of the evolutionary tree ranging from insects to mammals.

Unlike most humans, however, individual animals generally cannot be classified as gay or straight: an animal that engages in a same-sex flirtation or partnership does not necessarily shun heterosexual encounters. Rather many species seem to have ingrained homosexual tendencies that are a regular part of their society. That is, there are probably no strictly gay critters, just bisexual ones. "Animals don't do sexual identity. They just do sex," says sociologist Eric Anderson, now at the University of Winchester in England.

Nevertheless, the study of homosexual activity in diverse species may elucidate the evolutionary origins of such behavior. Researchers now understand, for example, that animals may engage in same-sex couplings to diffuse social tensions, to better protect their young or to maintain fecundity when opposite-sex partners are unavailable—or simply because it is fun. These observations suggest to some that bisexuality is a natural state among animals, perhaps *Homo sapiens* included, despite the sexual-orientation boundaries most people take for granted. "[In humans] the categories of gay and straight are socially constructed," Anderson says.

What is more, homosexuality among some species, including penguins, appears to be far more common in captivity than in the wild. Captivity, scientists say, may bring out gay behaviors in part because of a scarcity of opposite-sex mates. In addition, an enclosed environment boosts an animal's stress levels, leading to a greater urge to relieve the stress. Some of the same influences may encourage what some researchers call "situational homosexuality" in humans in same-sex settings such as prisons or sports teams.

Making Peace

Modern studies of animal homosexuality date to the late 19th century with observations on insects and small animals. In 1896, for example, French entomologist Henri Gadeau de Kerville of the Society of Friends of Natural Sciences and the Museum of Rouen published a drawing of two male scarab beetles copulating. Then, during the first half of the 1900s, various investigators described homosexual behavior in baboons, garter snakes and gentoo penguins, among other species. Back then, scientists generally considered homosexual acts among animals to be abnormal. In some cases, they "treated" the animals by, say, castrating them or giving them lobotomies.

At least one early report, however, was more than descriptive, yielding insight into the possible origins of the behavior. In a 1914 laboratory experiment Gilbert Van Tassel Hamilton, a psychopathologist practicing in Montecito, Calif., reported that same-sex behavior in 20 Japanese macaques and two baboons occurred largely as a way of making peace with would-be foes. In the *Journal of Animal Behavior,* Hamilton observed that females offered sex to the more dominant macaques of the same sex: "homosexual behavior is of relatively frequent occurrence in the female when she is threatened by another female, but

FAST FACTS
FIT TO BE GAY

1. Same-sex couplings are surprisingly widespread in the animal kingdom. Observers have witnessed as many as 1,500 species of wild and captive animals engaging in homosexual activity.
2. Animals may engage in homosexual acts to diffuse social tensions, to better protect their young or to maintain fecundity when opposite-sex partners are unavailable—or simply because it is fun.
3. Homosexuality among some species appears to be far more common in captivity than in the wild. Captivity may bring out gay behaviors because of a lack of opposite-sex mates and a greater need for stress relief.

PRECEDING PAGES: NICOLE BENGIVENO *Redux Pictures*

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it is rarely manifested in response to sexual hunger." And in males, he penned, "homosexual alliances between mature and immature males may possess a defensive value for immature males, since it insures the assistance of an adult defender in the event of an attack."

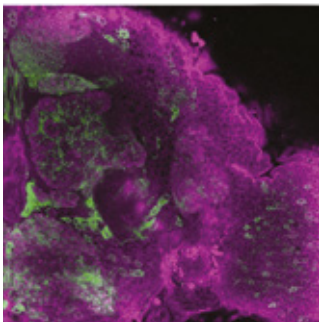
More recently, some researchers studying bonobos (close relatives of the chimpanzee) have come to similar conclusions. Bonobos seem highly promiscuous by human standards, and about half their sexual activity involves same-sex partners. Female bonobos rub one another's genitals so often that some scientists have suggested that their genitalia evolved to facilitate this activity. The female bonobo's clitoris is "frontally placed, perhaps because selection favored a position maximizing stimulation during the genital-genital rubbing common among females," wrote behavioral ecologist Marlene Zuk, now at the University of Minnesota, in her 2002 book *Sexual Selections: What We Can and Can't Learn about Sex from Animals*. Male bonobos have been observed to mount, fondle and even perform oral sex on one another.

Such behavior seems to ease social tensions. In *Bonobo: The Forgotten Ape* (University of California Press, 1997), Emory University primatologist Frans B. M. de Waal and his co-author photographer Frans Lanting noted that "when one female has hit a juvenile and the juvenile's mother has come to its defense, the problem may be resolved by intense [genito-genital] rubbing between the two adults." De Waal has observed hundreds of such incidents, suggesting that they may be a general peacekeeping strategy [see "Bonobo Sex and Society," by Frans B. M. de Waal, on page 42]. "The more homosexuality, the more peaceful the species," asserts Petter Bøckman, an academic adviser at the University of Oslo's Museum of Natural History in Norway. "Bonobos are peaceful."

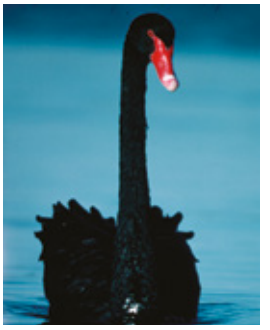
In fact, such acts are so essential to bonobo socialization that they constitute a rite of passage for young females into adulthood. Bonobos live together in groups of about 60 in a matriarchal system. Females leave the group during adolescence and gain admission to another bonobo clan through grooming and sexual encounters with other females. These behaviors promote bonding and give the new recruits benefits such as protection and access to food.

Female homosexual encounters among bonobos help the apes get along: they resolve conflicts and promote bonding.

Up to one quarter of black swan families include parents of the same sex.



In the fruit fly brain (*shown in cross section*), the protein genderblind (*purple*) abuts neurons that communicate using the neurotransmitter glutamate (*green*), a pattern consistent with the idea that genderblind influences a fly's sexual preference by modulating glutamate signaling.



PETER JOHNSON *Corbis (bonobos)*; COURTESY OF DAVID E. FEATHERSTONE, FROM: "A GLIAL AMINO-ACID TRANSPORTER CONTROLS SYNAPSE STRENGTH AND COURTSHIP IN *DROSOPHILA*," BY YAEL GROSJEAN ET AL., IN *NATURE NEUROSCIENCE*, VOL. 11, NO. 1; JANUARY 2008 (*fruit fly brain*); PETER JOHNSON *Corbis (black swan)*

"The more homosexuality, the more peaceful the species," one specialist says. "Bonobos are peaceful."

Defended Nest

In some birds, males steal eggs from females and raise them in same-sex unions. This might have evolved as a strategy to increase the survival of the species. "In black swans, if two males find each other and make a nest, they'll be very successful at nest making because they are bigger and stronger than a male and female," Bøckman says. In such cases, he observes, "having a same-sex partner will actually pay off as a sensible life strategy."

In other instances, homosexual bonding between female parents can boost the survival of offspring when male-female pairings are not possible. In birds called oystercatchers, intense competition for male mates would leave some females single were it not for polygamous trios. In a study published in 1998 in *Nature*, zoologist Dik Heg and geneticist Rob van Treuren, both then at the University of Groningen in the Netherlands, observed that roughly 2 percent of oystercatcher breeding groups consist of two females and a male. In some of these

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families, Heg and van Treuren found, the females tend separate nests and fight over the male, but in others, all three birds watch over a single nest. In the latter case, the females bond by mounting each other as well as the male. The cooperative triangles produce more offspring than the competitive ones because such nests are better tended and protected.

Such arrangements point to the evolutionary fitness of stable social relationships, whatever their type. Biologist Joan E. Roughgarden, now at the University of Hawaii, believes that evolutionary biologists tend to adhere too strongly to Darwin's theory of sexual selection and have thus largely overlooked the importance of bonding and friendship to animal societies and the survival of their young. "[Darwin] equated reproduction with finding a mate rather than paying attention to how the offspring are naturally reared," Roughgarden says.

Protection of progeny, social bonding and conflict avoidance may not be the only reasons animals naturally come to same-sex relationships. Many animals do it simply "because they want to," Bøckman says. "People view animals as robots who behave as their genes say, but animals have feelings, and they react to those feelings." He adds that "as long as they feel the urge [for sex], they'll go for it."

A finding from 2008 indicates that homosexual behavior may be so common because it is rooted in an animal's brain wiring—at least in the case of fruit flies. In a study appearing that year in *Nature Neuroscience,* neuroscientist David E. Featherstone of the University of Illinois at Chicago and his colleagues found that they could switch on homosexual leanings in fruit flies by manipulating a gene for a protein they call "genderblind," which regulates communication between neurons that secrete and respond to the neurotransmitter glutamate.

Males that carried the mutant *genderblind* gene—which depressed levels of the protein by about two thirds—were uncharacteristically attracted to the chemical cues exuded by other males. As a result, these mutant males courted and attempted to copulate with other males. The finding suggests that wild fruit flies may be prewired for both heterosexual and homosexual behavior, the authors write, but that the genderblind protein suppresses the glutamate-based circuits that promote homosexual behavior. Such brain architecture may enable same-sex behavior to surface easily, supporting the notion that it might confer an evolutionary advantage in some circumstances.

LET THEM BE GAY

Sometimes zookeepers do not know how to react to their animals' homosexual behavior. In 2005 workers at Bremerhaven's Zoo by the Sea in Germany discovered that three of their five endangered Humboldt penguin couples were of the same sex. The keepers brought in four female Humboldt penguins from Sweden in hopes of tempting the males. That action angered gay and lesbian groups around the world. In a letter to Bremerhaven's then mayor, Jörg Schulz, a group of European gay activists protested what they called "organized and forced harassment through female seductresses."

In the end, the males were not swayed anyway. "The males have scarcely thrown the females a single glance," said zoo director Heike Kück to German magazine *Der Spiegel.* So more males were flown in to keep the Swedish females company. —*E.V.D*

Wild koalas are heterosexual, but females living together in captivity in Brisbane, Australia, shrieked male mating calls and mated with one another.

In 2004 Silo (*right*) deserted his longtime male partner, Roy (*not shown*), for a female chinstrap penguin named Scrappy (*left*).

The Captivity Effect

In some less social species, homosexual behavior is almost unheard of in wild animals but may surface in captivity. Wild koalas, which are mostly solitary, seem to be strictly heterosexual. But in a 2007 study veterinary scientist Clive J. C. Phillips of the University of Queensland in Brisbane, Australia, and his colleagues observed 43 instances of homosexual activity among female koalas living in a same-sex enclosure at the Lone Pine Koala Sanctuary. The captive females shrieked male mating calls and mated with one another, sometimes participating in multiple encounters of up to five koalas. "The behavior in captivity was certainly enhanced in terms of homosexual activity," Phillips says.

He believes that the females acted this way in part because of stress. Animals often experience stress in enclosed habitats and may engage in homosexual behavior to relieve that tension. A lack of male partners probably also played a role, Phillips suggests. When female koalas are in heat, their ovaries release the sex hormone estrogen, which triggers mating behavior—whether or not males are pres-

PAUL MCELHONE *Getty Images (koalas);* CHANG W. LEE *Redux Pictures (penguins)*

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ent. This hardwired urge to copulate, even if expressed with a female partner, might be adaptive. "The homosexual behavior preserves sexual function," Phillips says, enabling an animal to maintain its reproductive fitness and interest in sexual activity. In males, this benefit is even more obvious: homosexual behavior stimulates the continued production of seminal fluid.

A lack of opposite-sex partners is also thought to help explain the prevalence of homosexuality among penguins in zoos. In addition to several gay penguin couplings in the U.S., 20 same-sex penguin partnerships were formed in 2004 in zoos in Japan. Such behavior "is very rare in penguins' natural habitats," says animal ecologist Keisuke Ueda of Rikkyo University in Tokyo. Thus, Ueda speculates that the behavior—which included both male pairings and female couplings—arose as a result of the skewed sex ratios at zoos.

Researchers have found still other reasons for homosexual behavior in domesticated cattle—which is such a common occurrence that farmers and animal breeders have developed terms for it. "Bulling" refers to male pairs mounting, and "going boaring" is its female counterpart. For cows, the behavior is not just a stress reliever. It is a way to signal sexual receptivity. The females mount one another to signal their readiness to mate to the bulls—which, in captivity, may cause a breeder to know when to bring in a suitable opposite-sex partner.

Homosexual mounting is much rarer among cattle in the wild, Phillips asserts, based on his research on gaurs in Malaysia, a wild counterpart to domesticated cattle. "Cattle evolved in the forest, so a visual signal was not going to be useful for them," he says.

Stress and the greater availability of same-sex partners may similarly contribute to the practice of homosexual acts among self-described heterosexual humans in environments such as the military, jails and sports teams. In a study published in 2008 in the journal *Sex Roles*, Anderson found that 40 percent of 49 heterosexual former high school football players attending various U.S. universities had had at least one homosexual encounter. These ranged from kissing to oral sex to threesomes that included a woman. In team sports, homosexuality is "no big deal, and it increases cohesion among members of that team," Anderson claims. "It feels good, and [the athletes] bond."

In some species, homosexual activity is almost unheard of in the wild but may surface in captivity.

In stressful same-sex environments such as prisons or a war zone, heterosexuals may engage in homosexual behavior in part to relieve tension. "Homosexuality appears mostly in social species," Bøckman says. "It makes flock life easier, and jail flock life is very difficult."

Altered Spaces

In recent decades zoo officials have tried to minimize the stresses of captivity by making their enclosures more like animals' natural habitats. In the 1950s zoo animals lived behind bars in barren enclosures. But since the late 1970s zoo homes have become more hospitable, including more open space, more objects for animals to play with and better keepers. The Association of Zoos and Aquariums (AZA) regulates everything from cage dimensions to animal bedding. The AZA also outlines enrichment activities for captive creatures: for instance, two golden brown Amur leopards at the Staten Island Zoo regularly play with a papier-mâché zebra, an animal they have never seen in the flesh.

Researchers hope such improvements might affect animal behavior, making it more like what occurs in the wild. One possible sign of more hospitable conditions might be a rate of homosexuality more in line with that of wild members of the same species. Some people, however, contest the notion that zookeepers should prevent or discourage homosexual behavior among the animals they care for [*see box on opposite page*].

And whereas captivity may engender what appears to be an unnaturally high level of homosexual activity in some animal species, human same-sex environments might bring out normal tendencies that other settings tend to suppress. That is, some experts argue that humans, like some other animals, are naturally bisexual. "We should be calling humans bisexual because this idea of exclusive homosexuality is not accurate of people," Roughgarden says. "Homosexuality is mixed in with heterosexuality across cultures and history."

Even Silo the penguin, who had been coupled with Roy for six years, displayed this malleability of sexual orientation. One spring day in 2004 a female chinstrap penguin named Scrappy—a transplant from SeaWorld in San Diego—caught his eye, and he abruptly left Roy for her. Meanwhile Roy and Silo's "daughter," Tango, carried on in the tradition of her fathers. Her chosen mate: a female named Tazuni. M

MORE TO EXPLORE

- **Biological Exuberance.** Bruce Bagemihl. St. Martin's Press, 1999.
- **Evolution's Rainbow: Diversity, Gender, and Sexuality in Nature and People.** Joan Roughgarden. University of California Press, 2004.
- **Heterosexual and Homosexual Behaviour and Vocalisations in Captive Female Koalas (*Phascolarctos cinereus*).** Stacey Feige, Kate Nilsson, Clive J. C. Phillips and Steve D. Johnston in *Applied Animal Behaviour Science,* Vol. 103, Nos. 1–2, pages 131–145; 2007.
- **A Test of Genetic Models for the Evolutionary Maintenance of Same-Sex Sexual Behaviour.** Jessica L. Hoskins, Michael G. Ritchie and Nathan W. Bailey in *Proceedings of the Royal Society B,* Vol. 282, No. 1809; June 2015.

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DO GAYS HAVE A CHOICE?

Science offers a clear and surprising answer to a controversial question

BY Robert Epstein

ON A TYPICAL SUMMER SATURDAY MORNING

Matt Avery and his wife, Sheila (not their real names), cook breakfast with their two sons, ages five and eight. Then they get organized with towels, goggles and water wings and load the family into the car for an afternoon at the pool. "Weekends are all about family time," Matt says.

Matt and Sheila have been happily married for more than 11 years. "She's my soulmate," Matt says. "I wouldn't trade my life for the world."

But some people would claim that Matt's life is based on an illusion—that he could not possibly be a dedicated husband and father. Why? Because Matt used to be gay.

According to the National LGBTQ Task Force and at least a few experts, gays do not have a choice about their sexual orientation. If a man or a woman is born gay, he or she will always be gay. Because Matt was gay for most of his young adulthood (ages 17 to 24), the thinking goes, he must *still* be gay today. Pressured by a homomisic society—a society that dislikes and shuns gays—Matt has simply run back inside the closet. Gay activists favor this perspective at least in part because survey data show that people are more sympathetic to gay causes if they believe that sexual orientation is immutable.

Does this perspective have merit? Or are religious conservatives correct in asserting that homosexuality is entirely a matter of choice? A wealth of scientific evidence provides clear answers. It turns out that sexual orientation is almost never a black-and-white matter. Rather it exists on a continuum, with both genes and environment determining where people end up, how much flexibility people have in expressing their sexual orientation, and even the extent to which sexual orientation might change over time.

Biblical Proportions

It is difficult for most people to think objectively about homosexuality, in large part because biases against it are literally of biblical proportions. According to the book of Leviticus, homosexuality—at least when practiced by males—is prohibited, punishable by death. Thousands of American pulpits to this day repeat the old biblical injunctions, which fuel discomfort with homosexuality at every layer of our society.

Until recent decades, prejudice against homosexuality has persisted even in the mental health professions. In the 1970s most therapists still held that homosexuality was a psychological disorder, akin to a disease. In the 1968 edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*)—the indispensable diagnostic tool used by therapists—homosexuality appeared

FAST FACTS
SEXUAL ORIENTATION

1. Some people who once considered themselves homosexuals are able to live happily as heterosexuals.
2. Sexual orientation falls along a continuum: some are exclusively attracted to members of the opposite sex; others, to the same sex; and many are somewhere in the middle.
3. Social pressure can push those in the middle toward heterosexuality. But because genes play a role, people with strong same-sex attractions probably cannot change their orientation.

PRECEDING PAGES: ALAN SCHEIN *Corbis*

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KEVIN FLEMING *Corbis*

The Stonewall Riots in Greenwich Village in 1969 initiated a shift toward greater cultural acceptance of homosexuality.

in the section on sexual deviations as an instance of an aberration in which sexual interests are "directed primarily toward objects other than people of the opposite sex."

It was largely gays themselves—understandably tired of being viewed as freaks of nature—who began to assert that their orientation was not pathological. A defining moment came on June 27, 1969, after a police raid on a gay bar in Greenwich Village in New York City provoked a riot. Crowds continued to gather at the site for another five days, protesting discrimination and preaching gay rights. Now called the Stonewall Riots (named after the Stonewall Inn, which was at the center of the melee), they galvanized the modern gay-rights movement in America and initiated a shift toward greater cultural acceptance of homosexuality.

A mere four years later, in 1973, the nomenclature committee of the American Psychiatric Association (APA) set about reassessing the profession's dark characterization of homosexuality. Leading the charge was the late psychiatrist Robert L. Spitzer of Columbia University [*see box on page 61*]. As a result of his committee's recommendation, the term "homosexuality" disappeared from the next edition of the *DSM*. That hardly settled the matter, however. More than a third of psychiatrists were opposed to the change when it was made, and subsequent editions of the *DSM* have recognized that people might seek help from a therapist for "marked distress" or "conflicts" about sexual orientation.

Changing "Truths"

Matt Avery had no doubt about his orientation when he first became sexually active in his teens. During college in the early 1980s, he worked at a gay bar and had hundreds of sexual partners. He also had a four-year relationship with a man. Matt considered himself "feminine." "I was 140 pounds, had long fingernails, a blond ponytail and wore an earring," he reminisces. "I was a sight to be seen."

But when he was 24, his partner returned from a weekend retreat with some incredible news. Being gay, his partner said, "wasn't a truth" for him. Matt was distraught. "My whole life," he says, "was defined by whomever I was with—whomever I could use to make up for my own faults." After their sexual relationship ended, they stayed roommates and friends. But then, Matt says, "he started dating this *woman*." "One day," he recalls, "I decided homosexuality might not be a truth for me either, and I went on a date with a woman. It was pretty good."

Within two or three years he found himself involved exclusively with women. He made the shift without therapy and without the influence of religious groups. He was supported, he says, by friends who helped him deal with "issues involving my father." They helped him learn to be comfortable with his masculinity. Matt got to the point where even his sexual fantasies about men disappeared. In that respect, he probably became straighter than many heterosexuals. Although Matt made the switch without professional assistance, others—sometimes under tremendous social pressure from family members or religious groups—seek out "reparative" therapists to help them become straight.

Floyd Godfrey—himself formerly gay—has been a reparative therapist in Arizona for more than 15 years. His office has 12 clinicians, and many of their clients over the years have been men struggling to overcome homosexual tendencies. Godfrey says they come because they are depressed, anxious and unhappy. "They feel out of place," he says. "They don't feel like one of the guys. When people feel like they don't fit in, that can produce depression."

Some, he says, are young men whose fathers were abusive or neglectful. "Their dad was never available for them to bond with. Or sometimes their mom was controlling or overprotective. The bottom line," Godfrey says, "is that

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there was a disruption during childhood of the bond that normally develops between father and son." Deficient upbringing, Godfrey claims, can sometimes lead to same-sex attractions.

Let us set aside the obvious question for the moment—whether the therapy works—and consider a more basic issue. Why is it called "reparative"? Doesn't this term presume that homosexuality is somehow invalid—that gays are like broken washing machines that need to be repaired? In other words, isn't this therapy a retrenchment to the old disease model of homosexuality that Spitzer and his colleagues dispatched more than 30 years ago?

It seems so. Those deeply entrenched notions affect even the way we talk about homosexuality. Even the common term "sexual preference" reflects bias, suggesting that orientation is entirely a matter of choice. As for the claim made by Godfrey and others that homosexuality is the result of poor parenting, there is simply no legitimate scientific evidence to support it. Whereas it is true that some homosexuals had poor relationships with their fathers when they were growing up, it is impossible to say whether those fathers produced homosexual tendencies in their sons by rejecting them or, instead, whether some fathers simply tend to shun boys who are effeminate at the outset.

As for the effectiveness of reparative therapy, in a landmark study published in October 2003 in the *Archives of Sexual Behavior,* Spitzer interviewed 200 men and women who once considered themselves homosexuals but who had lived their lives as heterosexuals for at least five years. Most of his subjects not only reported living long term (more than 10 years) as heterosexuals, they also declared they had experienced "changes in sexual attraction, fantasy and desire" consistent with heterosexuality. The changes were clear for both men and women.

Once again, though, this study hardly settled the matter. In a brief article published in 2012, Spitzer retracted his 2003 findings, saying that "there was no way to determine if the participants' accounts of the change [in their sexual orientation] were valid." Since then, the APA and other organizations have issued formal statements expressing doubts about the effectiveness and safety of reparative therapy, and both California and New Jersey have banned the practice (at least for licensed therapists).

As for the claim that homosexuality is the result of poor parenting, there is no scientific evidence.

AGE FOTOSTOCK

Continuity Rules

At the heart of the controversy about homosexuality are some microscopically small objects: the strands of proteins that make up our genes. Two genetic issues are relevant to our understanding of homosexuality. First, do genes play any role in sexual orientation? And second, if genes do help determine orientation, do they actually create two distinct types of orientation—gay and straight, as most people

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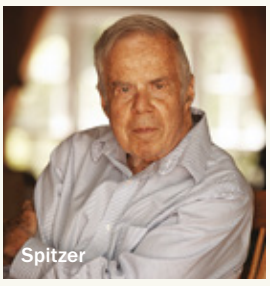
SWITCHING SIDES?

The late Robert L. Spitzer was an ardent Trotskyite in his youth, and his father was a Maoist. At one point, he was even the vice president of the NAACP chapter at Cornell University. Maybe his background explains why, in 1972, when the psychiatrist first witnessed a gay protest at a psychology convention, it was he who approached the protesters, not the other way around. He saw social injustice, and he wanted to help.

He told the protesters he was a member of the nomenclature committee revising the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*) for the American Psychiatric Association and that he would ask its members to allow gay activists to present their views. Ultimately the committee recommended that the term "homosexuality" be eliminated from the *DSM.*

Before his death in December 2015 at 83 years old, Spitzer, who had retired from his professorship at Columbia University, told me that neither



Spitzer

he nor his committee ever meant to suggest that homosexuality was normal or healthy; such a conclusion would be "very wrong." "Just because something is not a mental disorder doesn't mean it's normal," Spitzer explained.

What is more, he said, the committee was careful to preserve a category of dysfunction that allowed unhappy gays to seek change. "Distress" over one's sexual orientation was still listed as a disorder.

In 1999 Spitzer entered the sexuality fray again—this time approaching a group of self-proclaimed ex-gays who were protesting at a convention. That event led to his controversial 2003 study that suggested that some homosexuals can turn straight—a study that he eventually retracted, saying it was the only professional regret of his life [*see main text*].

In a 2012 letter to the editor of the journal where his study had appeared nine years earlier, Spitzer wrote that his study design made it impossible to determine whether reparative therapy could enable individuals to change their sexual orientation from homosexual to heterosexual. "I believe I owe the gay community an apology for my study making unproven claims of the efficacy of reparative therapy," he wrote. "I also apologize to any gay person who wasted time and energy undergoing some form of reparative therapy because they believed that I had proven that reparative therapy works with some 'highly motivated' individuals."

Formerly a hero to gays, for a decade Spitzer became the reluctant darling of the Christian right. Spitzer saw no contradictions in his actions. As he said to me before his death, "I think of myself as a guy who loves controversy, loves to be where the action is—and I did some courageous things." —*R.E.*

believe—or do they create a continuum of orientation?

A variety of studies suggest that genes play at least some role in homosexuality. Although no one study is entirely conclusive, studies of twins raised together, twins raised apart and family trees suggest—at least for males—that the more genes one shares with a homosexual relative, the more likely it is that one will be homosexual—the hallmark of a genetic characteristic. But more interesting for our purposes is the question of a continuum. Sometimes, as with eye color, genes create discrete characteristics. With many attributes, however, such as height and head width, genes create continuities. Whereas most people may believe that "straight" and "gay" are discrete categories, there is strong evidence that they are not—and this fact has important implications for the way we understand the different controversies that surround homosexuality.

Ever since the late 1940s, when biologist Alfred Kinsey published his extensive reports on sexual practices in the U.S., it has been clear, as Kinsey put it, that people "do not represent two discrete populations, heterosexual and homosexual.... The living world is a continuum in each and every one of its aspects." A position statement by the APA, the American Academy of Pediatrics and eight other national organizations agrees that "sexual orienta-

ALEX DI SUVERO *Redux Pictures*

THE AUTHOR

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tion falls along a continuum." In other words, sexual attraction is simply not a black-and-white matter, and the labels "straight" and "gay" do not capture the complexities.

For obvious evolutionary reasons, many people prefer opposite-sex partners because such relationships produce children who can continue the human race. But some—perhaps between 3 and 7 percent of the population—are exclusively attracted to members of the same sex, and many are in the middle. If a person's genes place him or her toward the straight end of what I call the Sexual Orientation Continuum, he or she almost certainly can never become homosexual [*see illustration on opposite page*]. If the genes place the person at the other end of the curve, he or she almost certainly cannot become straight—or at least not a happy straight. But if an individual is somewhere in between, environment can be a major influence, especially when the person is young. Because society strongly favors the straight life, in the vast majority of cases the shift will be toward heterosexuality.

In an extensive study published in 2012, with more than 17,000 participants from 48 countries, my colleagues and I confirmed that sexual orientation lies smoothly on a continuum, just as Kinsey said. We also found an extensive mismatch between the labels many people use to describe their sexual orientation—gay, straight and bisexual—and their actual sexual attractions, fantasies and behavior. Moreover, just as people differ on where they fall on the Sexual Orientation Continuum, we found that they also differ in their "sexual orientation range"—how much flexibility they have in expressing their sexual inclinations.

Psychologist Lisa Diamond of the University of Utah and other researchers have also shown that sexual orientation is fluid to some extent. That is, it can change over the years. This is especially true for women.

The way sexuality plays out is similar in some respects to the process by

HOW GAY ARE YOU?

To see where you fall on the Sexual Orientation Continuum, take this simple quiz, which is designed to produce a statistically correct distribution along the lines of the continuum shown in the illustration on the opposite page. For a more accurate picture of your sexual orientation, including an estimate of how much flexibility you have in expressing your orientation, take the author's full test at http://MySexualOrientation.com

How strongly are you attracted to members of the opposite sex?
__ 0 = Very strongly
__ 1 = Moderately
__ 2 = Not at all

Have you ever felt sexually attracted to a member of the same sex?
__ 0 = No
__ 1 = Yes

Have you ever had a dream about a sexual encounter with a member of the same sex?
__ 0 = No
__ 1 = Yes

Have you ever had a waking fantasy about a sexual encounter with a member of the same sex?
__ 0 = No
__ 1 = Yes

Have you ever voluntarily had sexual contact (such as kissing or petting) with a member of the same sex?
__ 0 = No
__ 1 = Yes

How frequent are your same-sex fantasies or dreams?
__ 0 = Never had them
__ 1 = Rare or occasional
__ 2 = Frequent

Have you ever felt sexually aroused when you've had any exposure to two people of your same sex having a sexual encounter (through gossip, a video or some other means)?
__ 0 = No
__ 1 = Yes

Would you be willing to have sexual relations with someone of the same sex?
__ 0 = No
__ 1 = Maybe
__ 2 = Yes

How frequent are your same-sex encounters?
__ 0 = Never had them
__ 1 = Rare or occasional
__ 2 = Frequent

Now add up the numbers and see where you stand:

0–1:
Exclusively heterosexual

2–3:
Predominantly heterosexual

4–5:
Predominantly heterosexual, with homosexual tendencies

6–7:
Equally heterosexual and homosexual

8–9:
Predominantly homosexual, with heterosexual tendencies

10–11:
Predominantly homosexual

12–13:
Exclusively homosexual

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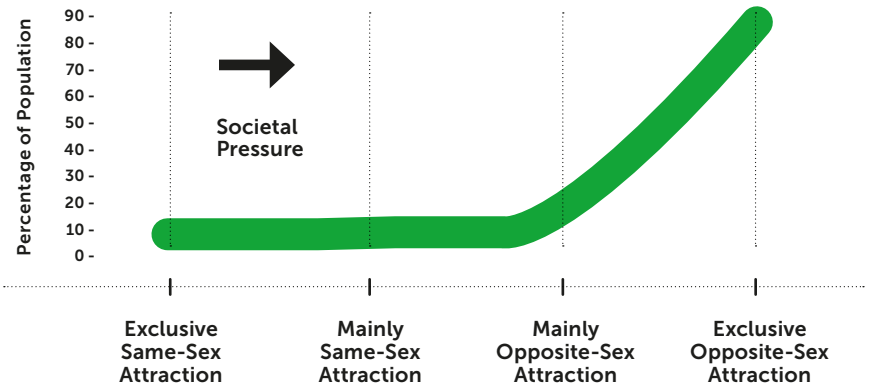
which people become left- or right-handed. It may sound contrary to common sense, but scientific studies suggest that genes play a relatively small role in handedness; its heritability—an estimate of what proportion of a trait's variability can be accounted for by genes—is only about 0.25, compared with, say, 0.84 for height and 0.95 for head width. Then why is more than 90 percent of the population right-handed? It is because of that cultural "push" working again. Subtle and not so subtle influences make children favor their right hand, and the flexibility they probably had when they were young is simply lost as they grow up. Although they can still *use* the left hand, their handedness becomes so well established that they would find it difficult, if not impossible, to become left-handed.

Studies by psychiatrist Niklas Långström of the Karolinska Institute in Stockholm and others suggest that the heritability of homosexuality is not much higher than that of handedness—perhaps in the range 0.25 to 0.50 or so for males and substantially lower for females. This finding raises an intriguing question: If people were raised in a truly orientation-neutral culture, what sexual orientation would they express? As shocking as this may seem, the large multinational studies my colleagues and I have been conducting in recent years suggest that without societal pressures to be straight, only a small percent of us would be exclusively heterosexual throughout our lives. Bisexuality was common among the ancient Greeks and Romans; have cultural and religious forces in modern times created the belief that same-sex attraction is a perversion?

The Sexual Orientation Continuum



The author's hypothetical curve, a theoretical extrapolation from statistical data, shows how sexual orientation is probably distributed across a large population. Sexual orientation lies on a continuum: it is not an all-or-nothing state.

Matt's Choice

As for Matt, it is likely that he, like most or all people who change sexual orientation, was not near an extreme end of the continuum to begin with. It is unreasonable to say that he has been returned to a "natural" state, however; with strong social support, he has simply chosen a new path for himself—one that his genes made possible but that is almost certainly not possible for every gay person. Someday I suspect that psychobiological research will allow us to find precise physical correlates of sexual orientation: genes, neural structures or perhaps more subtle physical characteristics. But no advances in science will ever completely resolve the moral and philosophical issues that Matt's conversion raises.

If people were raised in a truly orientation-neutral culture, what sexual orientation would they express?

Do gays have a choice? Because of the enormous pressures pushing all of us toward the straight end of the Sexual Orientation Continuum from the time we are very young, it is reasonable to assume that most of the people who currently live as homosexuals were probably close to the gay end of the continuum to begin with; in other words, they probably have strong genetic tendencies toward homosexuality. Even though some gays can apparently switch their sexual orientation, the vast majority probably cannot—or at least not comfortably. If you doubt that—and assuming that you are right-handed—try eating with your left hand for a day or two, and good luck with your soup. M

MORE TO EXPLORE

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DAVID JOHNSON *Workbook*

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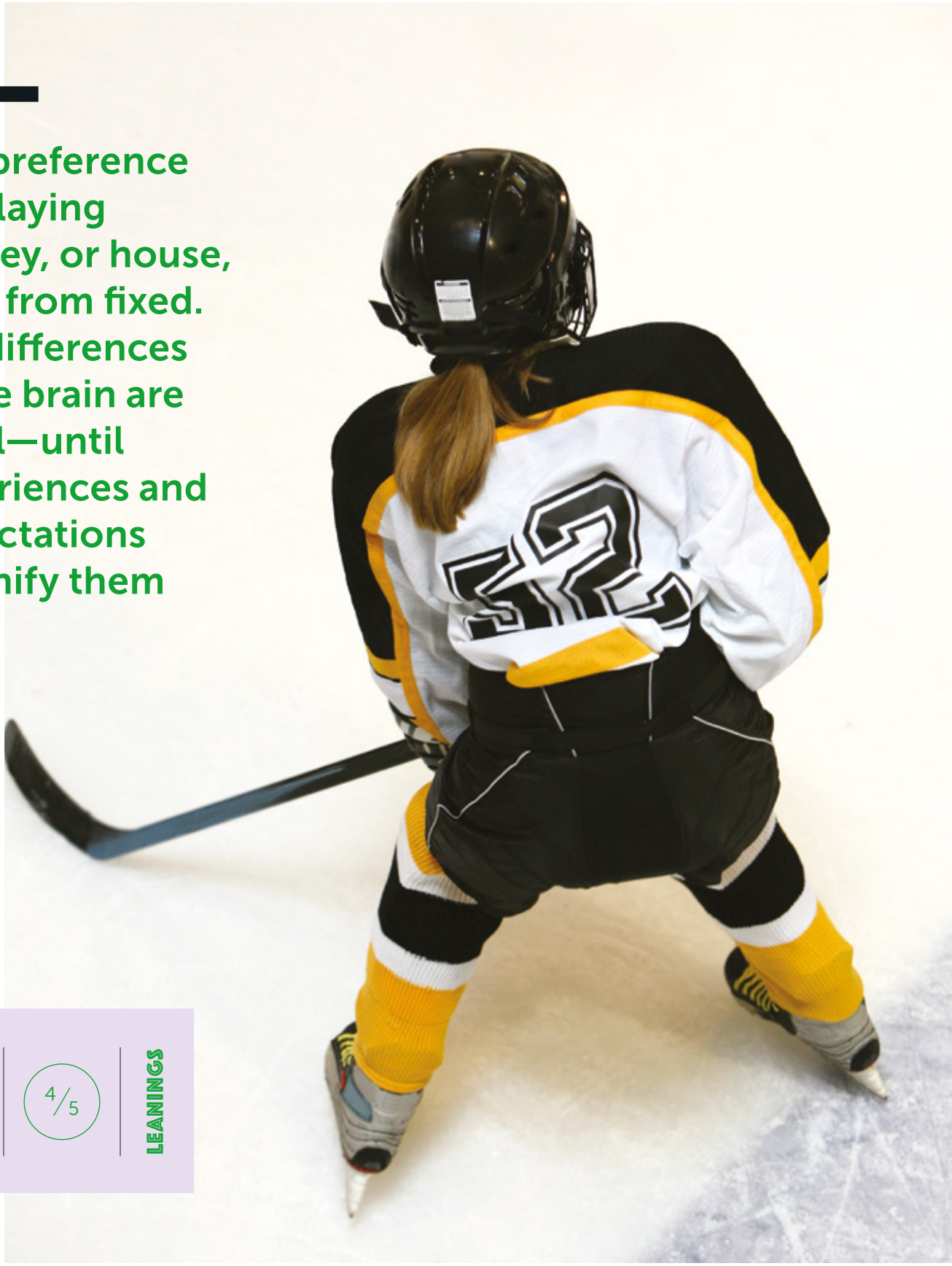
The preference for playing hockey, or house, is far from fixed. Sex differences in the brain are small—until experiences and expectations magnify them



THE SEXUAL BRAIN

4/5

LEANINGS

BY Lise Eliot

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THE TRUTH ABOUT BOYS AND GIRLS

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PARENTS ANTICIPATE SEX DIFFERENCES FROM THE FIRST PRENATAL ULTRASOUND BUT THEN SEEM AMAZED WHEN THEIR SON GOES GAGA OVER TRUCKS OR THEIR DAUGHTER WILL WEAR NOTHING BUT PINK. BOYS AND GIRLS ARE OBVIOUSLY

different, and in many cases the gaps between them seem stark. But stereotypes do not always hold up to scientific scrutiny. Are boys really more aggressive and girls really more empathetic—or do we just see what we expect in them? Where true sex differences do exist, are those disparities inborn, or are they shaped by environment—that is, by us?

A natural place to look for answers is in the brain. If there is a neurological disparity between the genders, it could explain important behavioral differences. But surprisingly, researchers have found very few notable differences between boys' and girls' brains, and even some of the widely claimed differences between adult men's and women's brains—such as the idea that women have stronger connections between left and right hemispheres—have not held up to rigorous research. Yes, males have larger brains (and heads) than females—from birth through old age. And girls' brains finish growing earlier than boys' do. But neither of these findings explains why boys are more active and girls more verbal or reveals a plausible basis for the consistent gaps in their reading, writing and science test scores that have parents and teachers up in arms.

Boys tend to be more rambunctious than girls. Same-gender peer groups amplify innate triggers, such as previous exposure to a relative abundance of testosterone in the womb.

Brain differences are indisputably biological, but they are not necessarily fixed, or hardwired. The crucial, often overlooked fact is that experience itself changes brain structure and function. Neuroscientists call this shaping plasticity, and it is the basis of all learning and much of children's mental development. Even the simple act of seeing depends on normal visual experience in early life, without which a baby's visual brain fails to wire up properly and his

FAST FACTS

BOY VS. GIRL?

1. Boys and girls are different, but most psychological sex differences are statistically small. For example, gaps in intellectual performance, empathy and even most types of aggression are generally much narrower than the disparity in adult height, in which the average man is taller than 98 percent of women.
2. Researchers have found few differences between boys and girls in brain structure or function. Boys have larger brains, and girls' brains finish growing earlier than boys' do. But neither of these findings explains why boys are more active and girls more verbal or reveals a plausible basis for any of the other emotional and cognitive differences between the sexes.
3. Experience itself changes brain structure and function. Most sex differences start out small—as mere biases in temperament and play style—but are amplified as children's pink- or blue-tinted brains meet our gender-infused culture.

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or her vision is permanently impaired.

Does growing up as a boy or as a girl also wire the brain in a particular way? Obviously, girls and boys are not identical at birth: genetic and hormonal differences must launch the male and female brains down somewhat different developmental pathways. But early experience, we now know, permanently alters the chemistry and function of the genes inside cells, leading to significant effects on behavior. Neuroscientist Michael J. Meaney and his colleagues at McGill University, among others, have found that the quality of maternal care is associated with a host of neural and psychological consequences—from the production of new brain cells to altered stress responses and memory function. The different ways parents raise boys and girls may similarly leave their stamps on children's developing brains.

Most sex differences start out small—as mere biases in temperament and play style—but are amplified as children's pink- or blue-tinted brains meet our gender-infused culture, including all the tea parties, wrestling matches, playground capers and cafeteria dramas that dominate boys' or girls' existence. Through better understanding of these environmental influences, we can break down some of the gaps between boys and girls—in school achievement, risk taking, self-control, competitiveness, empathy and assertiveness.

The Kickoff

Boys are more physically active than girls, in infancy and throughout childhood. They kick, swing their arms and race around the house noticeably more than girls do, as many exhausted parents can testify. The difference may emerge before birth, although some ultrasound studies fail to find a sex difference in fetal movement. Nevertheless, the disparity becomes apparent during the first year and expands through childhood, according to a 1986 analysis of more than 100 studies by psychologist Warren Eaton and his colleagues at the University of Manitoba in Canada. Their findings reveal that the average boy is more active than about 69 percent of girls.

Even male and female monkeys show a modest preference for gender-stereotyped toys, suggesting that there is something about vehicles, balls and moving parts that may resonate with boys' hormonal priming.

Boys' preference for trucks over dolls becomes stronger as parents, playmates and toy stores push gender-appropriate toys. But encouraging boys to act as caregivers can enhance their social sensitivity.

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That gap is statistically moderate, larger than differences in verbal and math skills but small enough to permit many exceptions to the rule, notably the 31 percent of girls who are *more* active than the average boy. Sex hormones—in particular, a relative abundance of testosterone in the womb during fetal development—may be responsible for boys' fidgetiness. And yet the sex difference in physical activity widens during childhood, despite the fact that sex hormone levels do *not* differ between boys and girls from six months of age to puberty.

Parenting is likely one factor amplifying the disparity. Mothers discourage physical risk taking more in daughters than in sons, according to studies both in the laboratory and on the playground. (Fathers encourage more risk taking in children than mothers do, but no one has tested the likely hypothesis that dads pressure sons more than daughters in this respect.) Peers also push conformity: in their preferred all-boy groups, energetic boys feed off one another, whereas energetic girls tend to settle down in clusters of more docile friends. In organized sports, girls start playing at a later age, quit earlier and join fewer teams overall than boys—cultural factors that amplify differences in physical skills.

As many schools eliminate recess or cut back on physical education, both genders are paying the price with higher rates of obesity and attention deficit/hyperactivity disorder diagnoses. Boys especially need more frequent physical breaks to satisfy their higher activity levels, and both sexes need the cognitive boost that exercise confers during a long school day. Exercise is also important

THE AUTHOR

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for maintaining a positive body image, which turns out to be the biggest risk factor for depression in adolescent girls.

Trucks and Dolls

Yes, boys like trucks and girls like dolls. Given a choice of Power Rangers, Tonka, Bratz and a Barbie beauty set, preschool-age boys and girls strongly prefer the gender-obvious picks. In fact, children's gendered toy choice is one of the largest sex differences in behavior, second only to sexual preference itself! But this preference is not present in early infancy, when boys have been found to like dolls as much as girls do. (All babies are strongly attracted to faces, for obvious survival reasons.) Toy gender preference does not emerge until the end of infancy, grows stronger through the preschool years, and then declines somewhat because of a complex interaction between nature and nurture.

Toddlers' toy preferences are shaped, in part, by prenatal testosterone: girls with a genetic disorder that exposes them to high levels of testosterone and other androgens before birth are more interested in toy trucks and cars than typical girls are. Even male and female monkeys show a modest preference for gender-stereotyped toys, which suggests that there is something about vehicles, balls and moving parts that may resonate with boys' hormonal priming, drawing them away from their initial face preference and toward toys they can interact with more physically.

Starting from this small bias, children's toy preferences grow more extreme through social shaping. In spite of claims of gender-neutral rearing, most parents reinforce play that is considered gender-appropriate, especially in their sons. Then, beginning at age three, peers perpetuate gender norms even more than adults do. For example, psychologists Karin Frey of the University of Washington and Diane Ruble of New York University found that elementary school–age boys and girls both opted for a less desirable toy (a kaleidoscope) over a much slicker movie viewer after watching a commercial of a same-sex child choosing the kaleidoscope and an opposite-sex child choosing the movie viewer.

By age five girls show greater latitude, choosing "boy" toys and "girl" toys equally. Boys, however, rarely do this crossover—a divergence that reflects different societal norms. Girls today are allowed—and even encouraged—to play sports, wear pants and build with Legos much more than boys are

Because physical aggression is a much greater taboo for girls than boys, girls learn to suppress overt belligerence. Instead they whisper and engage in best-friend wars that are much harder to police.

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pressed to don dresses and play house.

The different play preferences of boys and girls are important in shaping many brain circuits and later abilities. Sporting gear, vehicles and building toys exercise physical and spatial skills, whereas dolls, coloring books and dress-up clothes stimulate verbal, social and fine-motor circuits. Parents and preschool teachers can expand both sets of skills by encouraging girls to try puzzles, building blocks, throwing sports and video games, while enticing boys to sew, paint, and play as caregivers using props for doctor, Daddy, zookeeper, EMT, and the like.

Sticks and Stones

Boys are more physically aggressive than girls, according to many studies, including a 2004 analysis by psychologist John Archer of the University of Central Lancashire in England. That difference is linked to prenatal testosterone but not, surprisingly, to the resurgence in boys' testosterone level in adolescence, because boys do not suddenly become more aggressive when they go through puberty, as Archer's work also indicates. Nor is this sex difference absolute. Two- and three-year-old girls frequently kick, bite and hit other people—not quite as much as toddler boys but about three times more than either sex does later in childhood. In addition, girls fight with indirect, or relational, aggression. Through gossip, ostracism, whispers and harassing text messages, girls leave more scars on competitors' psyches than on their bodies.

Thus, both sexes compete and both sexes fight; what differs is the degree to which such behavior is overt or hidden. Because physical aggression is a greater taboo for girls than boys, they learn, even early in elementary school, to keep it below the surface, in the eye rolling and best-friend wars that teachers rarely notice and are harder to police.

But by admitting that competitive feelings are natural for all children, we can find ways to channel them into healthier pursuits. In recent years educators have tended to take competition out of the classroom, reasoning that the opposite style of interaction—cooperation—is more important in a civil society. But competition can be highly motivating, especially for boys, and girls need to develop greater comfort with open competition, which remains essential to success in our free-market society. One solution is team competitions, where groups of students work together to try to beat others at solving math, vocabulary, history and science problems.

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Girls score higher than boys on most measures of empathy. But grown-ups can nurture and encourage boys' natural sensitivity.

Competition can be highly motivating, especially for boys, and girls need to develop greater comfort with open competition, which remains essential to success in our free-market society.

I Know How You Feel

Aggression and empathy are inversely related. It is hard to attack someone if you are acutely aware of what he or she is feeling. So whereas men and boys score higher on measures of physical and verbal aggression, girls and women score higher on many measures of empathy, or the awareness and sharing of other people's emotions, according to psychologist Nancy Eisenberg of Arizona State University and her colleagues in studies dating back to the 1980s.

And yet the sex difference in empathy is smaller than most people realize and also strongly dependent on how it is measured. When men and women are asked to self-report their empathetic tendencies, women are much likelier than men to endorse statements such as "I am good at knowing how others will feel" or "I enjoy caring for other people." When tested using more objective measures, however, such as recognizing the emotions in a series of photographed faces, the difference between men and women is much smaller: the average woman is more accurate than just 66 percent of men.

In children, the difference is tinier still, less than half that found in adults, according to a report in 2000 by psychologist Erin B. Tone, now at Georgia State University, after analyzing more than 100 studies of sex differences in facial emotion processing in infants, children and adolescents. So although girls do start out a bit more sensitive to other people's faces and emotions, their advantage grows larger with age, no doubt because of their stronger communication skills, more practice at role playing with dolls and more intimate friendships as compared with boys.

Little is known about the neural

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basis for the sex difference in empathy, although a grape-size region on each side of the brain called the amygdala is likely to be involved. The amygdala is highly activated by faces. My own research group recently found that the amygdala is slightly larger, on average, in men than in women, a fact that seemingly belies men's lesser ability to recognize facial emotions.

Other studies reveal an imbalance in the activation of the right and left amygdala in men and women, however. When they are recalling highly charged emotional scenes—the kind that trigger empathetic responses—women's left amygdala is more strongly activated than their right amygdala, whereas the right amygdala is more strongly activated than the left in men, as indicated by both a study in 2004 led by neurobiologist Larry Cahill of the University of California, Irvine, and a report in 2002 by psychologist Turhan Canli, now at Stony Brook University, and his colleagues.

It is not yet known if this left-right difference in amygdala activation is related to empathy per se or if the same neural sex difference is present in children. Indeed, when it comes to emotionality, boys and girls differ much less in early life; if anything, baby boys are known to cry and fuss more than baby girls. As boys grow, they are taught to hide their expressions of fear, sadness and tenderness. Scientists agree that social learning largely shapes the male-female gap in emotional responding. Boys are toughened up in a way girls rarely are, making them less expressive and also less attuned to others' feelings. This training almost certainly leaves its imprint on the amygdala, one of the more plastic structures in the brain. Teaching girls to be more resilient and boys to be more sensitive is possible and beneficial for both genders.

Girl Talk

First, let us dispense with the urban legend that "women speak three times more words every day than men." The real numbers: 16,215 for women and 15,669 for men, according to a 2007 study of nearly 400 college students fitted with digital recorders, led by psychologist Matthias Mehl of the University of Arizona. Females do outscore males on most measures of speaking, reading, writing and spelling from early childhood and throughout life, but the gaps vary in magnitude across different countries and change with age.

Girls read more than boys, and the extra practice results in better scores on language proficiency tests. But schools with strong reading programs show that boys who read a lot are as verbally adept as their female classmates.

Language differences emerge early in development. As infants, girls begin talking about one month earlier than boys and are some 12 percent ahead of boys in reading skills when kindergarten begins. Girls' advantage in reading and writing continues to grow through school, until by 12th grade, an alarming 47 percent more girls than boys graduate as proficient readers, with an even larger gap for writing, a conclusion drawn from several decades of data collected by the U.S. Department of Education.

These gaps appear to shrink in adulthood, however. The average woman scores higher than just 54 percent of men on a combined measure of all verbal skills, as indicated by a 1988 analysis by psychologist Janet Hyde and her colleagues at the University of Wisconsin–Madison. That the difference is so tiny may explain why the neural bases for language or literacy differences have yet to be uncovered. In 2008 neuroscientist Iris Sommer and her colleagues at University Medical Center Utrecht in the Netherlands dispelled one popular theory—that women use both sides of the brain to process language, whereas men use mainly the left. In their comprehensive analysis of 20 functional MRI studies, the researchers detected no difference in the degree of language lateralization between men and women.

Similarly, there is scant proof that girls and women are better neurologically wired for reading. If anything correlates with reading skill, it is quite simply the amount of reading children do for pleasure outside school. Girls read more than boys, and this additional exposure makes a difference in their academic performance that grows over time.

Beginning at birth, a child's language exposure is the single most important determinant of his or her later verbal abilities. Large studies in several different countries demonstrate that gender accounts for at most 3 percent of the

Gender accounts for at most 3 percent of the variance in toddlers' verbal ability. By comparison, at least 50 percent is determined by a child's environment and language exposure.

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variance in toddlers' verbal ability, compared with at least 50 percent determined by a child's environment and language exposure. Thus, the more parents can immerse their sons in conversation, books, songs and stories, the better are boys' chances of getting off to a strong start in language and literacy skills. ABC and rhyming books are great for teaching phonemic awareness—the link between sounds and letters that is the first hurdle in learning to read. Boys often select different genres than girls do—especially nonfiction, comedy and action stories—so getting boys to read may be largely a matter of finding books and magazines that appeal to them. Schools with strong reading programs have managed to eliminate the difference between boys' and girls' scores, proving that this worrisome gap is more a matter of education and practice than inborn literacy potential.

Thinking in 3-D

If girls have the advantage in verbal skills, boys have it in the spatial domain—the ability to visualize and manipulate objects and trajectories in time and three-dimensional space. Sex differences in spatial skills are among the largest of the cognitive gaps. The average man can perform mental rotation—that is, he can imagine how a complex object would look when turned around—better than up to 80 percent of women.

In 2008 two research groups reported a sex difference in mental rotation in babies as young as three months of age, and other evidence suggests that this skill is influenced by prenatal testosterone. Yet the actual size of the skill gap is much smaller in children than in adults: among four-year-olds, the average boy outperforms just 60 percent of girls at mental rotation. So it seems likely that the skill improves in boys thanks to the wide range of visuospatial interests—targeting, building, throwing, and navigating through innumerable driving and shooting games—that they pursue far more than girls.

In support of this idea, neurobiologist Karin Kucian and her colleagues at

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To narrow the gender gap in spatial skills, girls can practice visualizing and moving objects through space by playing targeting games and sports such as archery, baseball and tennis.

University Children's Hospital in Zurich reported in a 2007 study that boys' and girls' brains display similar MRI patterns of neural activity while performing a mental rotation task that evokes different responses in the brains of adult men and women. So it appears that boys' and girls' brains diverge in spatial processing as they grow and practice different skills.

Spatial skills are important for success in several areas of science and higher math, including calculus, trigonometry, physics and engineering. Research by educational psychologist Beth Casey of Boston College shows that the spatial skill gap between boys and girls largely accounts for the consistent male advantage on the math SAT exam, an obvious hurdle for admission to engineering and other technical degree programs.

As important as they are, spatial skills are not something we deliberately teach in school. But many studies have shown they can improve with training, including playing video games. If boys naturally get more such practice in their extracurricular pursuits, girls may benefit from greater exposure to three-dimensional puzzles, fast-paced driving and targeting games, and sports such as baseball, softball and tennis.

Gender, Culture and the Brain

Boys and girls are different, but most psychological sex differences are modest in size. For example, gaps in verbal skills, math performance, empathy and even most types of aggression are generally much smaller than the disparity in adult height, in which the average five-foot, 10-inch man in the U.S. is taller than 98 percent of U.S. women. When it comes to mental abilities, males and females overlap much more than they differ.

Furthermore, few of these sex differences are as hardwired as popular accounts tend to portray. Genes and hormones light the spark for many boy-girl differences, but the flame is fanned by the very separate cultures in which boys and girls grow up. Appreciating how sex differences emerge can reduce harmful stereotyping and give parents and teachers ideas for cross-training boys' and girls' minds, to minimize their more troubling discrepancies and enable all children to more fully develop their diverse talents. M

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As a small child, Skyler rejected girly clothes and insisted on playing with boys. Puberty was a nightmare until he finally came out as the first trans kid in his school. Now 14 years old, he recently began cross-sex medical treatment.

TRANSGENDER

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ANSG KIDS

BY Francine Russo

PHOTOGRAPHY BY Timothy Archibald

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Debate is growing about how to meet their urgent needs

Skyler was counting down the days. In just a few months, the 14-year-old would attend a life-changing medical appointment. It would be the first step toward resolving body and identity issues that the teenager had been struggling with for years.

Skyler's sex at birth (or, to use trans terminology, his "assigned" gender) was female, yet he did not readily identify as a girl. From the age of four, Skyler hated wearing dresses, which he would rip apart with scissors. "It didn't feel like me," he says. Later he did not understand why he was told not to play football, soccer and kickball with the boys.

His confusion grew painful over time. Skyler's first period, at age 11, was traumatic. Every month he would spend an entire week at home, unable to face school. "I was at war with myself," he says, "and I struggled with depression. I'd pick at my skin and cut myself on my arms and shoulders and legs to distract myself."

By seventh grade he had learned about transgender identities at his public school. There had been a few other transgender children in the district, and he realized he felt trans. He began binding his size-DD breasts, albeit awkwardly and painfully, and investigating blogs, articles and YouTube videos on being transgender. He learned about puberty blockers, which could stop all further sexual development, but given how womanly his body had already become, thought—mistakenly—it might be too late for that option. "I just started to give up," he says. "And that's about the time I came out to my mom."

His mother, Corina, a preschool teacher, had long been concerned about Skyler's gender issues. She was supportive and, with the help of transgender advocate Aidan Key of Gender Odyssey, began seeking experts to help her child. In eighth grade Skyler came out at school, becoming the first openly trans kid there. Although there was some fumbling at first, the teachers began adopting masculine pronouns for him and us-

ing his new trans name, Skyler. After a long struggle with the administrators, the school finally created one gender-neutral bathroom for him to use.

Despite these initial hurdles at school, the cutting stopped. He finally felt "more at peace" with himself. But the challenge of a medically assisted biological transition remained. After a long wait, Skyler at last had an appointment set for November. The doctor would examine his physical health and review his gender history, psychological health, emotional maturity and a host of other details. But what would follow was unclear. In a case like this, a physician might prescribe puberty blockers to stall further development or—as Skyler hoped—cross-sex hormones to begin the development of more masculine attributes. Skyler got his wish. After a few months of testosterone, he says, "I feel like I'm really me, more masculine and proud. My mom says I walk taller. At the store, more people call me 'Sir.' "

It is hard to imagine a more momentous and complex set of decisions than those faced by young trans people like Skyler and the clinicians who seek to help them. As the media has spotlighted trans celebrities such as television personality Caitlyn Jenner and actress Laverne Cox and as society begins to better understand and accept trans people (perhaps even in the U.S. military), demand for medical and psychological support has exploded. But the biggest challenge—medically, psychologically and ethically—is the growing number of children (some as young as seven or eight) seeking treatment despite uncertain medical science. Distressed but supportive parents have been flooding the small number of U.S. clinics that specialize in helping transgender youth. In Los Angeles, for example, the Center for Transyouth Health and Development at Children's Hospital Los Angeles saw close to 400 patients in 2014 versus 40 in 2008. The center is currently adding three to four new patients a week.

No one can say how many transgender people are out there. A 2011 meta-analysis of population surveys from the University of California, Los Angeles's Williams Institute suggests that 0.3 percent of people in the U.S. feel strongly that they are transgender. One of the studies included in the analysis—from the University of Michigan—found that between 0.1 and 0.5 percent of Americans have taken medical steps to transition. Whether trans individuals take those steps or not, they are a vulnerable population. Transgender youth, according to a 2015 Boston-based study of data from electronic health records, face two to three times the risk of their peers for serious psychological issues, such as depression, anxiety disorders, self-harm and suicide. They urgently require attention.

Yet this area of medicine is so new that few clinics have enough qualified and experienced professionals to adequately screen these children and youth. A protocol, developed by Dutch scientists in the early 2000s and adopted by the International Endocrine Society, serves as a guideline for doctors helping young people transition, and researchers have recently confirmed that this approach yields good results for most patients. But clinicians are now debating how closely to follow it. A growing number of trans experts believe the recommendations are too cautious, that screening procedures are too onerous and that young people are forced to wait too long for treatment that could alleviate their misery. Veterans in the field counter that caution is essential given that treatment is largely irreversible and that gender identity can be fluid in the young, with some patients having second thoughts. A paucity of research makes it difficult for both sides to resolve the debate and determine what is best for their patients.

Insistent, Consistent and Persistent

As newly alerted parents arrive at clinics with boys who sew and dress in frilly outfits and girls who would not be caught dead doing either, experts have to diagnose whether these children have gender dysphoria. In this condition, people suffer distress because of a mismatch between the gender identity they experience and their biological sex as determined by chromosomes, gonads and genitals. (Until 2012, psychiatrists classified the condition as "gender identity disorder," a term now viewed as stigmatizing.)

Although adolescents may confuse the two, gender identity is different from sexual orientation. Norman P. Spack, a pediatrician, pediatric endocrinologist and founder of the gender clinic at Boston Children's Hospital, borrows language from one of his first transgender patients to explain: "Sexual orientation is who you go to bed with. Gender identity is who you go to bed *as*." In fact, Spack adds, "I could never predict the sexual orientation of my patients."

Furthermore, gender dysphoria is more than just rejecting the social and cultural roles assigned to a given gender. Many kids push back against these norms—as when a young boy rejects macho roughhousing to playing house or a girl prefers toy

FAST FACTS
BENDING GENDER

1. Studies suggest that 0.3 percent of people in the U.S. feel strongly that their biological sex does not correspond to their gender identity.
2. Researchers have developed a multipart transition process for young trans people that begins with careful screening, then blockers at the onset of puberty and later cross-sex hormones to allow them to undergo puberty in their affirmed gender, followed by surgery.
3. Some parents and clinicians are pushing back against the existing guidelines, seeking a more case-by-case approach.

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For years Lenessa wanted to be a girl and wear "flowy" dresses. Her mother helped her realize she was trans, and gradually other family members came to accept her identity. Her father reports she is flourishing.

soldiers to dolls—without any discomfort regarding sexual or gender identity.

But for some children, there is a nagging, painful conviction that the gender they are forced to present to the world does not reflect their true self. "There's a small subgroup of trans kids who, as soon as they can talk, are saying, 'I'm not the gender you think I am,' " says psychologist Diane Ehrensaft of the Child and Adolescent Gender Center at the University of California, San Francisco, Benioff Children's Hospital. Often, Ehrensaft says, these kids do not like their bodies.

Among children under the age of about 12 who cross-identify, in terms of how they dress and behave, only a minority will continue to see themselves as transgender after puberty. A 2008 study by psychologists Madeleine S. C. Wallien and Peggy T. Cohen-Kettenis, both then at VU University Medical Center in Amsterdam, followed 77 children who had been diagnosed with gender dysphoria between the ages of five and 12. At age 16 or later the researchers found that 43 percent of the teens were no longer gender-dysphoric and that 27 percent remained so (some could not be reached for follow-up). Of those who stopped cross-identifying, all the girls and half of the boys were heterosexual; the other half of the boys were either homosexual or bisexual.

In what has become the mantra of the field for recognizing clear-cut trans children, they are "insistent, consistent and persistent over time" in their identification with the gender opposite to the one that they were assigned. A 2013 study led by Thomas D. Steensma, a psychologist at VU University Medical Center, confirmed that the intensity and persistence of identifying with the opposite, nonassigned gender are powerful indicators in predicting who will remain trans. Working with 79 boys and 48 girls referred for gender dysphoria to VU University Medical Center before age 12, Steensma and his colleagues measured these factors through a questionnaire assessing cross-gender behavior through early childhood. At age 15 or later only 23 of the boys and 24 of the girls had persisted. Those who remained trans were more likely to have been insistent early on, saying, for example, "I am a boy" rather than "I wish I were a boy" or they would grow up to be a daddy, not a mommy. Still, Steensma cautions, it is hard to predict whether any specific child will persist as transgender.

Some children change their mind at critical junctures, such as after undergoing a "social transition" (changing their name, pronoun and appearance to live in their affirmed gender) or taking puberty blockers. Some children, Ehrensaft says, gradually realize that they are trans. Still others are more focused on gender expression: wishing to be the other gender and cross-dressing but in a playful, fantasy context, without any distress about their body. Some, she says, are "proto-gay" and likely in adolescence to come out as gay, lesbian or bisexual. Increasingly, many will identify as gender queer, saying, in effect, "I do not identify with either gender; I'm beyond gender" or "I do not fit into your male/female binary." Such kids, Ehrensaft says, "are our littlest gender outlaws."

Teens who identify as trans, says psychologist Laura Edwards-Leeper of Pacific University, may also be reacting to peer influences, family dynamics, or religious or cultural beliefs. In some cultures, for example, she says, individuals face less stigma for being transgender than for being homosexual. So it is complicated.

Setting the Standard

In many respects, the Netherlands serves as an exemplar for supporting trans and gender-questioning people. In October, Loiza Lamers (born as Lucas Lamers) won Holland's Next Top Model, the first transgender winner from any country. One Dutch teenager who began her social transition early in life feels that her experiences today are no different than those of her contemporaries. "I'm like any other high school girl," she says. "I love my dogs, spending lots of time with my girlfriends, going dancing."

The degree of social acceptance in the Netherlands may re-

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flect the country's long history of working with the trans community. Since 1975 clinicians at VU University Medical Center have counseled 5,000 adults and helped many hundreds of people transition to a different gender. As younger people came forward seeking guidance, Dutch experts established a second clinic for children and adolescents at University Medical Center Utrecht in 1987 that has since joined VU University Medical Center's clinic, known as the Center of Expertise on Gender Dysphoria. To date, they have counseled 1,000 young people, including some who, like the Dutch teen, have pursued a transition.

The procedure these clinicians developed became a template of sorts for the Endocrine Society's standards of care, now used around the world. The protocol first requires a series of psychological assessments. Given the potential fluidity of identity in a young person, careful screening is considered essential to identify which children should undertake the process of transitioning. Assuming kids meet the diagnosis of gender dysphoria, clinicians advise parents to wait until after puberty to see whether their child will persist. (Meanwhile many parents, with or without clinicians' encouragement, may help their children make a social transition before puberty.) At what doctors refer to as Tanner stage 2, when girls have tiny breast buds and boys have slightly enlarged testes, they can receive puberty blockers to prevent further sexual maturation. This stage's onset is variable but usually occurs between 10 and 12 years of age. At around age 16 those who persistently identify as transgender can receive cross-sex hormones, and at 18 they can elect to have gender-reassignment surgery. Throughout the process, the transitioning person must receive mental health support.

According to the first long-term research findings, young people who receive this kind of care do quite well. A 2014 study by psychiatrist Annelou L. C. de Vries of VU University Medical Center and her colleagues reported good results for 55 young people followed from before puberty suppression until after cross-sex hormonal treatment and surgery. Over this period, their psychological functioning steadily improved—with declining levels of gender dysphoria and anxiety and a greater sense of overall happiness. After treatment, their sense of well-being was similar to that of their peers who were not trans. All these transgender youth had identified as trans in childhood, de Vries says.

These recent positive outcomes are based on strict adherence to the protocols. But increasingly in both the U.S. and the Netherlands, with this research as a baseline, clinicians are making treatment decisions on a case-by-case basis. Guidelines recommend waiting until 18 for body-altering surgery, for instance, but some trans boys are having the most common operation—"top surgery," or breast removal—as early as 13 because binding breasts can cause pain or physical problems.

THE AUTHOR

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Payton McPhee began questioning his gender at age 11. Three years later he learned about female-to-male transitions and identified as trans male. "I was excited to finally have something to call myself," he says.

Even the Endocrine Society is revising its guidelines to be more flexible, says society committee member Stephen Rosenthal, a pediatric endocrinologist at the U.C.S.F. School of Medicine. Although "around 16" will still be the recommended age for cross-sex hormones, for example, newer standards will recognize "compelling reasons" to start earlier, such as to safeguard a child's physical or emotional welfare.

Parents are part of the push to address cases more individually. Gender transitions are complex at any age, but for a minor there is the added complication of reliance on adult guardians for consent and support.

Helping Younger Children Thrive

At age three, reports Marlo Mack (a nom de plume for her podcast How to Be a Girl), her child looked in her eyes and said, "Mama, something went wrong when I was in your tummy that made me come out as a boy instead of a girl. Put me back so I can come out again as a girl." For nearly a year Mack resisted her child's entreaties to be a girl. Then she grieved for her lost boy and loved and accepted her new daughter, a "girl with a penis."

Their therapist, Mack says, urged her to "take a wait-and-see attitude," at least until age five, before supporting a social transition. "I tried to do it," Mack says, "but I felt unsupportive and almost abusive." Thus, at the age of four and a half, Mack's child became a girl at home and in the world.

There is no medical treatment for prepubescent transgender children, but a growing community of clinicians is cautiously

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endorsing social transitions. Mack is one of an increasing number of parents in the U.S. who are helping their preschoolers to live as the gender they feel they are. In the Netherlands before the year 2000, Steensma says, almost none of the children referred to the Amsterdam clinic for gender dysphoria were presenting socially as their affirmed gender. By 2009 that percentage had risen to more than 33 percent, a reflection of similar parental support.

The most important question surrounding a social transition, according to psychiatrist Scott Leibowitz of Ann & Robert H. Lurie Children's Hospital of Chicago, is whether it helps the child thrive. Suppose a boy will not go to school except in a dress? "If a kid does go to school in a dress and does well," Leibowitz says, "I support it."

There is one big caveat for parents: be open to your child changing back. Families who, for example, have grieved their lost daughter and finally, painfully, accepted their new son may find it difficult to tolerate the ambiguity of their loss/gain. With the greatest love and best of intentions, they can trap their child in a mold that no longer fits. Edwards-Leeper recalls one patient who told her, "I can't change my mind. My parents have done so much for me."

In a 2011 review of adolescents at the Amsterdam clinic, Steensma found that children who had transitioned socially were indeed more likely to remain trans than those who had not come out in their community. But he is unsure whether the social transition helped or hindered all of these kids. For instance, Steensma says, two adolescent girls who were no longer trans struggled for some time to change back to their female identity because of "fear of teasing and shame to admit they had been wrong." He wonders whether counseling children on coping with their gender variance until early puberty might be a lesser evil than having them make a complete social transition twice, including a name and pronoun change.

"One True Test of Gender"

Adolescence is a powerful time—physically, psychologically and socially—in determining lasting gender identity, experts say. At this point, young people often decide who they are and are not. Some young people may discover they are or may be trans. In a 2011 qualitative study of 25 teens, Steensma found that along with feelings about the changes in their bodies, the children's responses to a new social environment provided clues to their gender identity. They were now confronting a world in which boys and girls divide and hang out with their same-sex peers. They might have also been experiencing their first sexual and romantic feelings.

Despite pressure from an increasing number of parents to use blockers before Tanner stage 2 and the onset of puberty, the medical community agrees that waiting is essential. "Some parents are *so* convinced their child is trans," Spack says, "that they don't want their child to have any natural hormones. These parents bring their kids in as young as age seven or eight. If we did that, we'd take away the one true test of gender: puberty. If the kid accepts the body they get at puberty, how can the parents say, 'My child is in the wrong body?'"

At or after Tanner stage 2, endocrinologists administer puberty suppression through either leuprolide acetate injections on a regular basis or surgical insertion of an implant that slowly releases histrelin. These are drugs that mimic the body's natural signal to stop producing hormones.

Doctors who treat trans kids say that puberty blockers are probably safe. Initially there had been concern about a negative impact on bone density, which normally increases during puberty. Fortunately, studies that followed children who had taken these drugs for "precocious puberty" into adulthood found that they appeared to have relatively normal bone density and no other serious effects—at least for the 30-year follow-up period, says pediatric endocrinologist Daniel Metzger of BC Children's Hospital in Vancouver.

After kids stop taking blockers, the effects disappear within six months, and they resume their natal puberty or take cross-sex hormones and go through puberty as their affirmed gender. Some kids remain on blockers when they take cross-hormones to prevent any unwanted pubertal changes that could happen on small doses of cross-hormones.

The medical purpose is to temporarily halt menstruation and the development of breasts, beards and other sexual characteristics, reducing the need for later surgeries and procedures and enhancing the quality of any gender change. Doctors often determine the length of treatment to prolong growth for trans boys and to curtail height for trans girls.

Psychologically, blockers reduce the distress of adolescents who, like Skyler, might otherwise harm themselves in reaction to pubertal changes. Most of all, puberty suppression gives young adolescents additional time to mature, to determine their true gender identity and to more fully evaluate the irreversible effects of taking the next step: cross-sex hormones.

Despite compelling need, some adolescents cannot get blockers. They may be too far into puberty when they recognize themselves as trans or may not be able to afford the treatment, which is often not covered by insurance. Injections of leuprolide acetate cost $700 to $1,500 a month, and histrelin implant surgery totals about $15,000. Cheaper substitutes such as progesterone have potentially serious side effects, including the risk of blood clots. For these reasons, some doctors may start young teens on more affordable cross-sex hormones instead of blockers.

A Rift in the Field

At each stage of transitioning, parents and clinicians have begun questioning the existing standards, particularly for children who appear to be "clearly" trans and therefore might benefit from a different approach. Some of these transgender youth specialists, such as pediatrician Johanna Olson, director of the Center for Transyouth Health and Development, consider themselves as advocates for the children. "We have no specific, lengthy, neuropsychiatric screening protocol," Olson says of her clinic. She feels that current measures of gender dysphoria are

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inadequate. "Our model is to listen to the young people. They are like snowflakes. They each need an approach that is individually tailored to their needs."

Perhaps the most controversial issue in the transitioning process is how long teens should wait before taking cross-sex hormones—for trans females, this means estrogen and antiandrogens; for trans males, testosterone. Among their other results, estrogens produce feminizing effects such as enlarging breasts and distributing fat in a more female pattern. Testosterone halts menstruation and promotes the growth of masculine-type body hair, male muscle mass, voice deepening and other male characteristics.

Depending on when puberty begins, it could easily take half a decade before someone qualifies for this step, according to the strict protocol. More and more, the "advocate" side of the field has called to stop keeping these children "on the sidelines" while their peers go through puberty. For clear-cut trans kids, therefore, many clinicians are increasingly comfortable giving cross-sex hormones at 14 or even younger.

But veteran practitioners, such as Edwards-Leeper, worry about moving too fast. As at other stages, the concern remains that a young person may not persist in a trans identity yet feel pressured to continue. Some patients, she says, feel as though they are "'stuck' in a gender or on a runaway train that is hard to get off." And unlike earlier stages, the stakes are higher: cross-sex hormones have irreversible effects on physical development.

Added complications arise with adolescents who only at puberty discover they may be trans. Payton McPhee of British Columbia is an example. A tomboy as a child, Payton began questioning his gender at 11 as friends began getting crushes. At 13 he realized he was attracted to girls. He came out as a lesbian, he says, "but it still didn't feel right." At 14 he met his first trans person and looked up "female-to-male" online. He was transfixed. "I was excited to finally have something to call myself," he says.

With the support of his parents and doctors, Payton began taking birth-control pills to reduce his period to twice a year. By binding his breasts and doing vocal exercises to lower his voice, he says, he can "pass" as a boy. Now 15, he would like testosterone therapy. But his parents and doctors are not yet convinced. "His psychiatrist said that at the very least, Payton is gender-fluid," reports his mother, Sarah McPhee, "and most likely transgender."

Clinicians are seeing kids like Payton show up in increasing numbers. But whether they should get cross-sex hormones, wait or take small doses for a short time to "explore" their gender is an open question. Some kids may be confused, says Harvard Medical School psychologist and gender expert Amy Tishel-

WHERE DOES GENDER LIVE IN THE BRAIN?

Some children insist, from the moment they can speak, that they are not the gender indicated by their biological sex. So where does this knowledge reside? And is it possible to discern a genetic or anatomical basis for transgender identity? Exploration of these questions is relatively new, but there is a bit of evidence for a genetic basis. Identical twins are somewhat more likely than fraternal twins to both be trans.

Male and female brains are, on average, slightly different in structure, although there is tremendous individual variability. Several studies have looked for signs that transgender people have brains more similar to their experienced gender. Spanish investigators—led by psychobiologist Antonio Guillamon of the National Distance Education University in Madrid and neuropsychologist Carme Junqué Plaja of the University of Barcelona—used MRI to examine the brains of 24 female-to-males and 18 male-to-females—both before and after treatment with cross-sex hormones. Their results, published in 2013, showed that even before treatment the brain structures of the trans people were more similar in some respects to the brains of their experienced gender than those of their natal gender. For example, the female-to-male subjects had relatively thin subcortical areas (these areas tend to be thinner in men than in women). Male-to-female subjects tended to have thinner cortical regions in the right hemisphere, which is characteristic of a female brain. (Such differences became more pronounced after treatment.)

"Trans people have brains that are different from males and females, a unique kind of brain," Guillamon says. "It is simplistic to say that a female-to-male transgender person is a male trapped in a female body. It's not because they have a male brain but a transsexual brain." Of course, behavior and experience shape brain anatomy, so it is impossible to say if these subtle differences are inborn.

Other investigators have looked at sex differences through brain functioning. In a study published in 2014, psychologist Sarah M. Burke of VU University Medical Center in Amsterdam and biologist Julie Bakker of the Netherlands Institute for Neuroscience used functional MRI to examine how 39 prepubertal and 41 adolescent boys and girls with gender dysphoria responded to androstadienone, an odorous steroid with pheromonelike properties that is known to cause a different response in the hypothalamus of men versus women. They found that the adolescent boys and girls with gender dysphoria responded much like peers of their experienced gender. The results were less clear with the prepubertal children.

This kind of study is important, says Baudewijntje Kreukels, an expert on gender dysphoria at VU University Medical Center, "because sex differences in responding to odors cannot be influenced by training or environment." The same can be said of another 2014 experiment by Burke and her colleagues. They measured the responses of boys and girls with gender dysphoria to echolike sounds produced by the inner ear in response to a clicking noise. Boys with gender dysphoria responded more like typical females, who have a stronger response to these sounds. But girls with gender dysphoria also responded like typical females.

Overall the weight of these studies and others points strongly toward a biological basis for gender dysphoria. But given the variety of transgender people and the variation in the brains of men and women generally, it will be a long time, if ever, before a doctor can do a brain scan on a child and say, "Yes, this child is trans." —*F.R.*

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man, "and this is a way to glom onto an identity." These kids may turn out to be trans. Or they may be more gender-fluid and need to experiment.

Dianne Berg, a psychologist and gender expert at the University of Minnesota, has seen some transitioning adolescents who identify as neither stereotypically male nor female and have parents pushing them to fit a more traditional mold. "It is hard for parents to wrap their head around their teen saying, 'I want to be a man, but I don't want to be a manly man—I want to be a more feminine kind of man,'" Berg says.

Metzger recalls a female-to-male patient who, at 13, wanted to transition and, at 16, got testosterone. Halfway through treatment, when the patient had a little facial hair and a bit more male bone structure, he asked to go on a lower dose, telling his doctor he was "a femme kind of boy." Metzger believes he has since had his ovaries removed and has remained on a lower dose of testosterone. "Is that *safe?*" the endocrinologist asks. "No one knows the answers."

Difficult Trade-offs

One of the thorniest issues about age is whether an 11- or even 14-year-old can understand the implications of a treatment that means he or she can never have biological children. Although it is theoretically possible for adolescents to experience enough natal puberty for boys to preserve sperm and girls to harvest eggs, it is rare for natal males to do this, and clinicians say that natal girls categorically reject it. Thus, in effect, when adolescents agree to cross-sex hormones, they or their parents are consenting to lifelong infertility.

Can a young teen understand this? It depends. As 22-year-old trans male Zachary Kerr of Methuen, Mass., recalls about the decision to take testosterone, "I blocked out everything that wasn't good because I wanted it. I was 16. I didn't care."

Other clinicians say that parents must choose for their children, just as they would if a treatment for cancer resulted in permanent infertility. "For some of these kids," says Michele Angello, a psychotherapist and gender specialist in Wayne, Pa., "the outcome is grim if we don't treat." As it is with so many issues these young people face, families and clinicians must recognize that each case is unique and that there are risks on every side. "There is no one right answer," Olson says. "Trans kids throughout life have to decide between bad choices."

More broadly, it is this keen awareness of the challenges that young trans individuals face and the limits of current knowledge that motivate concern on both sides of ongoing debates. Day to day, clinicians are doing their best to navigate between the known and unknown, but answers to at least some key questions may soon be coming. In August 2015 the National Institutes of Health awarded $5.7 million to four major transgender centers for a five-year study of the physical and psychosocial outcomes of treatment for transgender youth.

Ultimately the best course will be to balance the ability to individualize care with caution. "Those of us doing this the longest," Edwards-Leeper says, "feel more concern. Because we see how complex these cases are, and we understand brain development and child and adolescent development. Some newer doctors who just want to advocate for the children can lose sight of the bigger picture."

And both clinicians and families agree that a larger battle of acceptance and tolerance is still being fought. Despite the outpouring of government research funds, media attention and transgender pride in places such as Los Angeles and Seattle, it is important to remember that through great swaths of this country, trans kids face ignorance, blocked pathways and stigma.

Lenessa (not her real name), a gentle, soft-spoken 15-year-old trans girl from a small town in Texas, came close to becoming a statistic at age 11. From her youngest childhood, she had wanted to be a girl and wear "flowy" dresses, she says, but she was not allowed. While her two brothers roughhoused outside, she would read and sew indoors. The start of puberty was a shock. "I will never forget how horrible it was," she says. "It started to become permanent that I was a boy—becoming a man."

When, with her mother's help, she realized that she was trans and told her family, her father and grandmother rejected her. "Except my mom," she says, "everyone I loved seemed not to want to be with me. That's when I *really* didn't want to live." To protect her from her suicidal impulses, her mother took her to a psychiatric hospital. For her father, it was "a wake-up call." "I wanted a live child," he says, "not a dead son."

Even with both parents agreeing, finding a way forward was hard. Neither Lenessa's school nor her pediatrician had ever heard of being trans. Long searching led them to Ximena Lopez at the gender clinic at Children's Medical Center Dallas, which is affiliated with the University of Texas Southwestern Medical Center.

Today Lenessa is on blockers and, her father says, is flourishing. They have moved to a place where no one knew them before, and the girl who is now Lenessa will start high school in the fall, wearing the dresses that she loves. She hopes to eventually start hormones and develop a more womanly body. She says she understands the sacrifice she will be making: "It makes me sad when I realize I can't have my own children. But sometimes in life, when you really want something, you have to accept things you don't like." M

MORE TO EXPLORE

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From Our Archives

- **Coming Out Trans: 1 Man's Experience.** Francine Russo; *Scientific American Mind* online, January 1, 2016.

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THE SEXUAL BRAIN

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COUPLING

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POWERS OF TWO

Pairing up might have been the best move our ancestors ever made

BY Blake Edgar

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MAMMALS ARE NOT BIG ON MONOGAMY.

In fewer than 10 percent of species is it common for two individuals to mate exclusively. The primate wing of the group is only slightly more prone to pairing off. Although 15 to 29 percent of primate species favor living together as couples, far fewer commit to monogamy as humans know it—an exclusive sexual partnership between two individuals.

Humans obviously have an imperfect track record. People have affairs, get divorced and, in some cultures, marry multiple mates. In fact, polygamy appears in most of the world's societies. Yet even where polygamy is permitted, it is the minority arrangement. Most human societies are organized around the assumption that a large fraction of the population will pair off into enduring, sexually exclusive couples. And monogamy seems to have done our species good. "Pair bonds," as scientists call monogamous relationships, were a crucial adaptation that arose in an archaic forebear and became central to human social systems and our evolutionary success. "We have a very big advantage over many other species by having pair bonds," says University of Montreal anthropologist Bernard Chapais.

The monogamous couple also forms the basis for something uniquely human—the vast, complex social networks in which we live. Other primate young establish kinship links only through their mother; humans trace kinship from both parents, broadening each generation's family ties. Among humans, social networks extend to include other families and even unrelated groups in widening ripples of relationships. In Chapais's view, such group ties, along with monogamy, constitute "two of the most consequential features of human society."

Scientists have struggled for decades to understand the origins and implications of human monogamy. Basic questions such as when we started to pair up for life, why it was advantageous and how coupling might have spurred our success as a species remain unresolved and contentious, but new research has brought us closer to solving the mystery.

The Origins of Coupling

It is entirely possible that our most distant ancestors were monogamous. Fossil evidence, says anthropologist C. Owen Lovejoy of Kent State University, suggests that monogamy predates even *Ardipithecus ramidus,* the species best known from a 4.4-million-year-old partial female skeleton, nicknamed "Ardi," discovered in the Middle Awash region of Ethiopia. In Lovejoy's hypothesis, soon after the split from the last common ancestor between the great ape and human evolutionary branches more than seven million years ago, our predecessors adopted a transformative trio of behaviors: carrying food in arms freed by bipedal posture, forming pair bonds and concealing external signals of female ovulation. Evolving together, these innovations gave hominins, the tribe that emerged when early humans diverged from chimpanzees, a reproductive edge over apes.

According to this hypothesis, an ancestral polygamous mating system was replaced by pair bonding when lower-ranked hominin males diverted energy from fighting one another toward finding food to bring to females as an incentive to mate. Females preferred reliable providers to aggressive competitors and bonded with the better foragers. Eventually females lost the skin swelling or other signs of sexual receptivity that would have attracted different males while their partners were off gathering food.

For evidence, Lovejoy points to *Ar. ramidus*'s teeth. Compared with living and fossil apes, *Ar. ramidus* shows a stark reduction in the differences between male and female canine-tooth size. Evolution has honed the daggerlike canines of many male primates into formidable weapons used to fight for access to mates. Not so for early hominins. Picture the canines in a male gorilla's gaping jaws; now peer inside your own mouth. Humans of both sexes have small, stubby canines—an unthreatening trait unique to hominins, including the earliest *Ardipithecus* specimens.

A rough correlation also exists between mating behavior in primates and sexual dimorphism—that is, differences in body mass and size between males and females of the same species. The more dimorphic a primate species is, the more likely it is that males fight over females. At one extreme, polygamous gorilla

FAST FACTS

THE EVOLUTION OF MONOGAMY

1. Even in societies where polygamy is permitted, monogamy is by far the most common human mating arrangement. In this regard, we are unusual animals: fewer than 10 percent of mammals form exclusive sexual relationships.
2. How humans got this way has been the subject of scientific debate for decades, and it is still an open question. But new research is clarifying matters.
3. We now know that the first hominins, which emerged more than seven million years ago, might have been monogamous. Humans stayed (mostly) monogamous for good reason: it helped them evolve into the big-brained world conquerors they are today.

PRECEDING PAGES: MARTIN O'NEILL

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Silverback male mountain gorilla (*at right*) leads his troop in Rwanda. Gorillas, which are polygamous, live in small groups consisting of one dominant male, multiple female mates and their offspring.

males grow to be more than twice as massive as females. At the opposite extreme, both male and female gibbons, which are mainly monogamous, are nearly equal in mass. Humans lie closer to gibbons on the dimorphism spectrum: human males can be up to 20 percent more massive, on average, than females.

There is only so much we can make of the fossil record, though. Paleoanthropologist J. Michael Plavcan of the University of Arkansas urges caution in making the leap from fossilized bones to social behavior in hominins. Consider *Australopithecus afarensis,* the species to which "Lucy" belonged, which lived between 3.9 million and three million years ago. Like *Ardipithecus, A. afarensis* had small canines, but its skeleton displays a level of dimorphism between that of modern chimpanzees and gorillas. "You have [a level of] body-size dimorphism suggesting that [*A. afarensis*] males were competing for females and [a] loss of canine dimorphism that suggests they weren't," Plavcan says. "It's a puzzle."

Many anthropologists also dispute Lovejoy's conclusion that monogamy nurtured by males providing food for their mates and offspring has been a hominin strategy for millions of years. In April 2013 in the journal *Evolutionary Anthropology,* Chapais argued that the unique features of human family and social structure (monogamy, kinship ties through both parents and expanding social circles) emerged in a stepwise sequence. Before the first step, Chapais said, both male and female hominins were, like chimpanzees, promiscuous with partners. Then came a transition to polygamy, which is found in gorillas. But keeping many mates is hard work. It involves a lot of fighting with other males and guarding females. Monogamy might have emerged as the best way to reduce the effort of polygamy.

Chapais declines to speculate about when this shift happened and what species were involved. But other researchers are homing in on the period between two million and 1.5 million years ago, after the origin of our genus *Homo* and coincident with physical changes that show up in *Homo erectus,* most likely the first hominin species to successfully migrate beyond Africa. *H. erectus* possessed a much larger body, proportioned more like that of a modern human, than its predecessors. Roughly twice the size of Lucy's species, *H. erectus* also seems to be less sexually dimorphic than australopithecines and the earliest members of *Homo*. Limited fossil evidence suggests that *H. erectus* females started to approach the physical stature of males and to have a similar degree of dimorphism as in modern humans, which together could suggest that *H. erectus* had a less competitive way of life than its ancestors. Because primates with similar body sizes tend to be monogamous, this change

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could signal a shift toward more exclusive mating behavior. *Homo naledi,* an extinct hominin reported in 2015 but not yet dated, seems to follow a similar body size trend. Some 1,550 fossils from at least 15 individuals show remarkably little size variation among the same bones in different adult skeletons.

A Strategic Partnership

If scientists cannot agree on when humans became monogamous, we can hardly expect them to agree on why it happened. In 2013 two independent research teams published separate statistical studies of existing literature to determine which behaviors could have been drivers of monogamy. Both studies aimed to find the best explanation for monogamy among three persistent hypotheses: female spacing, infanticide avoidance and male parental care.

The female-spacing hypothesis posits that monogamy arises after females begin to establish larger territories to gain more access to limited food resources and, in the process, put more distance between one another. With females farther apart, males have a harder time finding and keeping multiple mates. Settling down with a single partner makes life easier, reducing a male's risk of being injured while patrolling his territory and enabling him to ensure that his mate's offspring are his own.

Zoologists Dieter Lukas and Tim Clutton-Brock, both at the University of Cambridge, found evidence for this idea in a statistical analysis of 2,545 species of mammals. They described their findings in a paper published in *Science*. The data indicated to them that mammals started out solitary, but then one species or another switched to monogamy 61 different times during their evolutionary history. Monogamy most frequently emerged in carnivores and primates, suggesting that species will tend toward mating in pairs when its females require a rich but rare diet (such as protein-rich carcasses or ripe fruits) that can usually be obtained only by searching a large area. Their findings provided the strongest statistical support for the conclusion that increasingly scattered, solitary females drove males to solicit single partners.

Lukas acknowledges that although the hypothesis may work for nonhumans, it might not be so apt for humans: it is difficult to reconcile the inherent sociality of humans with a hypothesis that depends on a low density of available females. It may be that our ancestors were too social for females to have been scattered across the savanna like other mammals. But the theory could potentially hold for humans if monogamy arose in hominins before our tendency to dwell in groups did.

Azara's owl monkeys of South America are fully monogamous, with the father handling much of the child care.

The second leading hypothesis holds that monogamy originated from the threat of lethal violence toward offspring. If a rival male challenged or supplanted a dominant male in a community, the usurper could kill infants that he had not sired. Mothers would stop lactating and start ovulating again, giving the marauding male a chance to spread his genes. To prevent infanticide, a female would select a male ally who could defend her and her baby.

Anthropologist Kit Opie of University College London cites evidence for the infanticide-avoidance hypothesis in a study published in the *Proceedings of the National Academy of Sciences*. Opie and his colleagues ran computer simulations of primate evolutionary history for 230 primate species; they then applied what is called a Bayesian statistical analysis to determine which of the three prominent hypotheses for the origin of monogamy had the highest probability of being correct. They identified a significant correlation between monogamy in primates and each of the three hypothetical triggers, but only an increase in the threat of infanticide consistently preceded the appearance of monogamy in multiple primate lineages.

The biology and behavior of modern primates add some plausibility to the conclusion that infanticide is a spur to monogamy. Primates are uniquely at risk for infanticide: they have big brains that need time to develop, which leaves babies dependent and vulnerable for long periods after birth. And the killing of babies has been observed in more than 50 primate species; it typically involves a male from outside a group attacking an unweaned infant in a bid for dominance or access to females. But there are limits to the evidence: nearly all these species have either promiscuous or polygamous mating systems, so the distribution of infanticide in living primates does not fit the prediction that monogamy should evolve when infanticide is a big threat.

The third hypothesis for why monogamy evolved highlights a male pulling his weight with parental duties. When a baby becomes too costly in terms of calories and energy for a mother to raise on her own, the father who stays with the family and provides food or other forms of care increases his offspring's chances of survival and encourages closer ties with the mother.

A related idea, proposed by anthropologist Lee Gettler of the University of Notre Dame, holds that the mere carrying of offspring by fathers fosters monogamy. Mothers have to meet the considerable nutritional demands of nursing infants. Yet for primates and human hunter-gatherers, hauling an infant, especially without the benefit of a sling or other restraint, required an expense of energy comparable to breast-feeding. Carrying by males could have freed females to fulfill

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their own energetic needs by foraging.

South America's Azara's owl monkey may offer some insight into how paternal care would reinforce monogamy. These monkeys live in small family groups, with an adult male-and-female pair and an infant, plus a juvenile or two. A mother monkey carries a newborn on her thigh just after birth. But the baby's father assumes most of the carrying and caretaking—grooming, playing and feeding—from the time the baby is two weeks old. The adult partners literally stay in touch with frequent tail contact, and the male's mere proximity to both the female and his young may strengthen emotional ties.

Indeed, a study published in March 2014 in the *Proceedings of the Royal Society B* presented genetic evidence that Azara's owl monkey pairs remain monogamous—the first genetic confirmation for any nonhuman primate. DNA collected from several study groups revealed that all the females and all but one of the males in 17 pairs were the most likely parents of 35 offspring. "They go all the way and commit to a monogamous relationship in genetic terms," says anthropologist Eduardo Fernandez-Duque of Yale University, a co-author of the study. Mating bonds between Azara's owl monkeys last an average of nine years, and monkeys that stay with the same partner achieve greater reproductive success—the end game of evolution under any mating system.

What do the two recent statistical studies have to say about the paternal care hypothesis? Both concluded that paternal care seemed the least likely among the competing hypotheses to trigger monogamous mating—but, Lukas says, "paternal care may still explain why a species *stays* monogamous."

It Takes a Village

A monogamous set of parents is not enough to raise an ape as smart and social as a human, says anthropologist Sarah Hrdy of the University of California, Davis. A human baby consumes some 13 million calories on its long journey from birth to maturity, a heavy burden for a mother to bear even with a mate helping. This demand might explain why in many societies, human mothers rely on "alloparents" (such as the kin of either parent or other group members) to help provide food and child care. "Human mothers are willing to let others hold their babies right from birth," Hrdy notes. "That's amazing, and it's remarkably unapelike." No ape engages in anything like alloparenting.

Hrdy maintains that cooperative breeding, a social system in which alloparents help care for young, evolved among our ancient ancestors starting with *H. erectus* nearly two million years ago. This species had a much larger body and brain than its ancestors; by one estimate, it took 40 percent more metabolic energy to run an *H. erectus* body relative to previous hominins. If *H. erectus* started down a humanlike path of delayed development and prolonged dependency, cooperative alloparents might have been required to support the energetic demands of raising bigger-brained babies.

Without cooperative breeding, conclude Karin Isler and Carel van Schaik, both at the University of Zurich, early *Homo* would not have broken through the hypothetical "gray ceiling" that constrains an ape's brain to a maximum volume of about 700 cubic centimeters. To pay the energetic cost of having an enlarged brain, an animal must reduce its rate of birth or its rate of growth, or both. But humans have achieved shorter weaning periods and greater reproductive success than a creature with a brain volume ranging from 1,100 to 1,700 cm^3 should have been able to. Isler and van Schaik attribute this success to alloparenting, which enabled *H. erectus* to have offspring more frequently while providing those offspring enough energy to grow a large brain.

Keeping many mates is hard work. It involves a lot of fighting with other males and guarding females. Monogamy might have emerged as a way to reduce that effort.

It was cooperation, then, whether in the form of monogamous pairs, nuclear families or tribes, that enabled humans to succeed when all our fossil ancestors and cousins went extinct. In fact, cooperation may be the greatest skill we have acquired during the past two million years—one that enabled our young genus to survive through periods of environmental change and stress and one that may well determine our geologically young species' future. M

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THE HAPPY COUPLE

BY Suzann Pileggi Pawelski

THE SEXUAL BRAIN

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The key to keeping the magic alive in a marriage, experts say, is finding ways to promote the positive

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Lisa, an elementary school teacher from Ambler, Pa., came home from work one day and said to her husband, "Honey, guess what? I landed that summer teaching position I wanted!" "Wow, congratulations!" he replied. "I know how hard you worked to get that job. I am so happy for you! You must be really excited." The way Lisa's husband reacted to her good news was also good news for their marriage, which, more than 20 years later, is still going strong; such positive responses turn out to be vital to the longevity of a relationship.

Numerous studies show that intimate relationships, such as marriages, are the single most important source of life satisfaction. Although most couples enter these relationships with the best of intentions, many break up or stay together but languish. Yet some do stay happily married and thrive. What is their secret?

A few clues emerge from the latest research in the nascent field of positive psychology. Founded in 1998 by psychologist Martin E. P. Seligman of the University of Pennsylvania, this discipline includes research into positive emotions, human strengths and what is meaningful in life. In recent years positive psychology researchers have discovered that thriving couples accentuate the positive in life more than those who stay together unhappily or split do. They not only cope well during hardship but also celebrate the happy moments and work to build more bright points into their lives.

It turns out that how couples handle good news may matter even more to their relationship than their ability to support each other under difficult circumstances. Happy pairs also individually experience a higher ratio of upbeat emotions to negative ones than people in unsuccessful liaisons do. Certain tactics can boost this ratio and thus help to strengthen connections with others. [To measure your positivity ratio, see box on page 90.] Another ingredient for relationship success: cultivating passion. Learning to become devoted to your significant other in a healthy way can lead to a more satisfying union.

Let the Good Times Roll

Until recently, studies largely centered on how romantic partners respond to each other's

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misfortunes and on how couples manage negative emotions such as jealousy and anger—an approach in line with psychology's traditional focus on alleviating deficits. One key to successful bonds, the studies indicated, is believing that your partner will be there for you when things go wrong. Then, in 2004, psychologist Shelly L. Gable, currently at the University of California, Santa Barbara, and her colleagues found that romantic couples share positive events with each other surprisingly often, leading the scientists to surmise that a partner's behavior also matters when things are going well.

Mutual support and enthusiasm in *good* times are essential to a successful relationship, according to the latest research in positive psychology.

In a study published in 2006 Gable and her co-workers videotaped dating men and women in the laboratory while the subjects took turns discussing a positive and negative event. After each conversation, members of each pair rated how "responded to"—how understood, validated and cared for—they felt by their partner. Meanwhile observers rated the responses on how active-constructive (engaged and supportive) they were—as indicated by intense listening, positive comments and questions, and the like. Low ratings reflected a more passive, generic response such as "That's nice, honey." Separately, the couples evaluated their commitment to and satisfaction with the relationship.

The researchers found that when a partner proffered a supportive response to cheerful statements, the "responded to" ratings were higher than they were after a sympathetic response to negative news, suggesting that how partners reply to good news may be a stronger determinant of relationship health than their reaction to unfortunate incidents. The reason for this finding, Gable surmises, may be that fixing a problem or dealing with a disappointment—though important for a relationship—may not make a couple feel joy, the currency of a happy pairing.

In addition, couples who answered good news in an active-constructive way scored higher on almost every type of measure of relationship satisfaction than those who responded in a passive or destructive way. (Passive replies indicate a lack of interest, as in changing the subject, and destructive responses include negative statements such as "That sounds like tons of work!") Surprisingly, a passive-constructive response ("That's nice, honey") was almost as damaging as directly disparaging a partner's good news. These data are consistent with an earlier study showing that active-constructive responders experience fewer conflicts and engage in more fun activities together. These individuals also are more likely to remain together. Active-constructive responding shows that a person cares about why the good news is important, Gable says, conveying that you "get" your partner. Conversely, negative or passive reactions signify that the responder is not terribly interested—in either the news or the person disclosing it.

Thankfully, life affords many opportunities to respond supportively to optimistic announcements: Gable, along with social psychologist Jonathan Haidt, now at New York University Stern School of Business, reported in 2005 that, for most individuals, positive events happen at least three times as often as negative ones. And just as responding enthusiastically to your partner's good news increases relationship satisfaction so does sharing your own positive experiences. In a daily diary study of 67 cohabiting couples published in 2010 in *Advances in Experimental Social Psychology*, Gable found that on days when

FAST FACTS

CELEBRATION TIME

1. In the past few years psychologists have discovered that thriving couples accentuate the positive in life more than those who languish or split do. They not only cope well during hardship but also celebrate the happy moments and work to build more of these into their lives.
2. How couples handle good news may matter even more to their relationship than their ability to support each other under difficult circumstances.
3. Members of happy couples also individually experience a higher ratio of upbeat emotions to negative ones than people in unsuccessful pairings do. Certain tactics can boost this ratio and thus help to strengthen bonds with others.

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couples reported telling their partner about a happy event they also reported feeling a stronger tie to their partner and greater security in their match.

Power of Positive Emotions

One of the benefits of reveling in the good times is a boost in the positive emotions of both members of a couple. Nearly two decades ago positive psychology pioneer Barbara L. Fredrickson of the University of North Carolina at Chapel Hill showed that positive emotions, even fleeting ones, can broaden our thinking and enable us to connect more closely with others. Having an upbeat outlook, she argues, enables people to see the big picture and avoid getting hung up on small annoyances. This wide-angle view often brings to light new possibilities and offers solutions to difficult problems, making individuals better at handling adversity in relationships and other parts of life. It also tends to dismantle boundaries between "me" and "you," creating stronger emotional attachments. "As positivity broadens your mind, it shifts your core view of people and relationships, bringing them closer to your center, to your heart," Fredrickson says.

When a person's positive sentiments outnumber negative feelings by three to one, that individual tends to become more resilient in life and love, Fredrickson found. Among individuals in enduring and mutually satisfying marriages, ratios tend to be even higher, hovering around five to one, according to research by world-renowned marriage expert John Gottman, emeritus professor of psychology at the University of Washington.

In her book *Positivity* (Crown, 2009), Fredrickson lists the 10 most frequent positive emotions: joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe and love. Although all these emotions matter, gratitude may be one of the most important for relationships, she says. Expressing gratitude on a regular basis can help you appreciate your partner rather than taking his or her small favors or kind acts for granted, and that boost in appreciation strengthens your relationship over time.

Passive responses to exuberant announcements indicate a lack of interest—and are almost as damaging to a relationship as directly disparaging a partner's good news.

Life affords many opportunities to respond supportively to optimistic announcements: positive events happen at least three times as often as negative ones, one study suggests.

In a study published in 2010 in *Personal Relationships,* social psychology researcher Sara B. Algoe, also at Chapel Hill, and her colleagues asked cohabiting couples, 36 percent of whom were married or engaged, to report nightly for two weeks how grateful they felt toward their partners from their interactions that day. In addition to gratitude, they numerically rated their relationship satisfaction and their feelings of connection with their partner. On days that people felt more gratitude toward their partner, they felt better about their relationship and more connected to him or her; they also experienced greater relationship satisfaction the *following* day. Additionally, their partners (the recipients of the gratitude) were more satisfied with the relationship and more connected to them on that same day. Thus, moments of gratitude may act as a booster shot for romantic relationships.

The fact that gratitude affected both partners also hints that *expressing* your gratitude is important for relationship satisfaction. To test this idea directly, Algoe, Fredrickson and their colleagues asked people in romantic relationships to list nice things their partners had done for them lately and to rate on a scale from 1 (not at all) to 7 (very much) how well they thought they had expressed appreciation to their partner for having done those favors. The researchers found that each unit improvement in expressed appreciation decreased by half the odds of the couple breaking up in six months.

Promoting Passion

Like gratitude, feelings of passion can strengthen our bonds with others. Many people equate passion with a desperate

THE AUTHOR

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HOW POSITIVE ARE YOU?

Although all healthy relationships involve some negative feelings, positive emotions form the foundation of any strong pairing. Psychologist Barbara L. Fredrickson of the University of North Carolina at Chapel Hill found that individuals who thrive in and outside relationships tend to experience a ratio of three or more positive emotions for every negative one in their daily lives. To find out how you compare, take the following quiz, called the Positivity Self Test, developed by Fredrickson in 2009.

___ 1. What is the most amused, fun-loving or silly you felt?

___ 2. What is the most angry, irritated or annoyed you felt?

___ 3. What is the most ashamed, humiliated or disgraced you felt?

___ 4. What is the most awe, wonder or amazement you felt?

___ 5. What is the most contemptuous, scornful or disdainful you felt?

___ 6. What is the most disgust, distaste or revulsion you felt?

___ 7. What is the most embarrassed, self-conscious or blushing you felt?

___ 8. What is the most grateful, appreciative or thankful you felt?

___ 9. What is the most guilty, repentant or blameworthy you felt?

___ 10. What is the most hate, distrust or suspicion you felt?

___ 11. What is the most hopeful, optimistic or encouraged you felt?

___ 12. What is the most inspired, uplifted or elevated you felt?

___ 13. What is the most interested, alert or curious you felt?

___ 14. What is the most joyful, glad or happy you felt?

___ 15. What is the most love, closeness or trust you felt?

___ 16. What is the most proud, confident or self-assured you felt?

___ 17. What is the most sad, downhearted or unhappy you felt?

___ 18. What is the most scared, fearful or afraid you felt?

___ 19. What is the most serene, content or peaceful you felt?

___ 20. What is the most stressed, nervous or overwhelmed you felt?

INSTRUCTIONS

Using the scale below, indicate the greatest degree to which you have experienced each of the following emotions during the previous 24 hours.

0 = NOT AT ALL
1 = A LITTLE BIT
2 = MODERATELY
3 = QUITE A BIT
4 = EXTREMELY

SCORING

Circle questions 1, 4, 8, 11, 12, 13, 14, 15, 16 and 19 and then underline questions 2, 3, 5, 6, 7, 9, 10, 17, 18 and 20.

Count the number of circled (positivity) questions you rated 2 or higher and the number of underlined (negativity) questions you scored 1 or higher.

Divide your positivity tally by your negativity tally. (If your negativity tally is zero, replace it with a 1.) The result represents your positivity ratio for today.

If you scored below 3:1, as most Americans do, you may be able to raise that ratio with exercises recommended in this article and in Fredrickson's book, *Positivity* (Crown, 2009). Because this test provides a mere snapshot of your feelings during the previous 24 hours, you may also want to repeat it nightly for two weeks to gain a more reliable assessment of your positivity ratio.

For more details and a convenient way to test yourself, visit www.positivityratio.com.

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longing, suggested by song lyrics such as "I can't live without you" and "You are always on my mind." But such unbridled or obsessive passion is not conducive to a healthy relationship, according to work by social psychologist Robert J. Vallerand of the University of Quebec at Montreal. On the contrary, obsessive passion—a type that seems to control you—is as detrimental to the relationship, making it less satisfying sexually and otherwise, as having no passion.

A healthy passion—a voluntary inclination toward an activity or person that we love and value—does provide benefits, however. In recent studies using the Romantic Passion Scale, a questionnaire that measures harmonious and obsessive passion, Vallerand found that harmonious passion helps couples relate better, in part, by enabling them to become intimate with their partner while maintaining their own identity, which helps to foster a more mature partnership. Their intimacy enables them to continue to pursue their own hobbies and interests rather than subjugating their own sense of self to an excessive attachment to the other person. (Previous research by Vallerand and his colleagues revealed that harmonious passion for activities leads to cognitive and emotional advantages, such as better concentration, a more positive outlook and better mental health. No one has yet studied whether these benefits spill over to our romantic relationships, however.)

You can cultivate healthy passion by joining your partner in a pursuit that both of you enjoy, Vallerand suggests. Engaging in exhilarating activities with another person has been shown to boost mutual attraction. Avoid serious competition because the point of the outing should not be winning but enjoying time together. Another tip: write down and share with your partner some of the reasons why you love him or her and why your relationship is important.

Positive Steps

Experts also have tips for injecting positive emotions into your life. First, learn to respond constructively to your partner's positive declarations. Look for opportunities to express your interest, support and enthusiasm. Acknowledge a terrific presentation at work, say, or faster time in a road race. Ask yourself regularly: "What good news has my partner told me today? How can we celebrate it?" Affirm your partner's joy first. Discuss your concerns, such as the practical downsides of a promotion, at a later time. In addition, be attentive and actively participate in the conversation. Ask questions and indicate interest nonverbally: maintain eye contact, lean forward and nod. To show you heard, rephrase a part of what he or she said, for instance: "You seem really excited about this new job."

Many people equate passion with a desperate longing, but such unbridled or obsessive passion is not conducive to a healthy relationship, recent research indicates.

Moreover, a variety of exercises can boost your ratio of positive to negative emotions. Schedule exuberant feelings into your day by, say, making time for activities that evoke such emotions. Locate places you can walk to quickly to connect with nature or other beautiful scenery. Make these places regular destinations for exercising, reflecting or hanging out with friends. In addition, practice savoring a genuine source of positive emotion that is currently, has been or will be a part of your life. Truly cherish the event by focusing intently on the feelings it evokes.

Another idea for raising your personal positivity score: create a "positivity portfolio," a collection of meaningful mementos signifying a positive emotion. For example, you might encapsulate joy by creating a collage of uplifting song lyrics and pictures that make you smile. Looking at your creation every day for 20 minutes can improve your positivity score. Try infusing fun or pleasure into mundane tasks. For instance, transform dinner preparation into a family activity in which the kids help by measuring ingredients and slicing vegetables, perhaps learning about nutrition along the way, Fredrickson says. Or play romantic or fun music during the dinner-making process. Turn daily challenges or snafus, like your child's misplaced shoes, into a game to see who can find them first.

Look for opportunities to thank your partner. "Try highlighting those small moments in which your partner has been thoughtful and expressing it to him or her," Fredrickson suggests. And find time each day to share something positive that has happened to you. M

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HE SA SHE

Men and women have different ways of speaking, but research reveals the conversational gender divide is not as stark as it seems

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THE SEXUAL BRAIN

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COUPLING

AID, SAID

BY Deborah Tannen

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WHY DON'T MEN LIKE TO STOP AND ASK DIRECTIONS?

This question, which I first addressed in my 1990 book *You Just Don't Understand: Women and Men in Conversation*, garnered perhaps the most attention of any issue or insight in that book. It appeared on cocktail napkins ("Real men don't ask directions") and became a staple of stand-up comics as well as jokes that made the rounds: "Why did Moses wander in the desert for 40 years?" and "Why does it take so many sperm to find just one egg?"

The attention surprised me. I had not known how widespread this experience was, but I included the asking-directions scenario because it crystallized key aspects of a phenomenon that, I had discovered, accounts for many of the frustrations that women and men experience in conversation. I have spent more than three decades collecting and analyzing thousands of examples of how women and men interact and have found that men's talk—both voice-to-voice and through social media—tends to focus on relative hierarchy, and women's tends to focus on relative connection. In other words, a man and woman might walk away from the same conversation asking different questions: he might wonder, "Did that conversation put me in a one-up or one-down position?" whereas she might wonder, "Did it bring us closer together or push us farther apart?"

But wait! All conversations, and all relationships, reflect a combination of hierarchy and connection—the two are not mutually exclusive but inextricably intertwined. All of us aspire to be powerful, and we all want to connect with others. Since the publication of *You Just Don't Understand*, I have continued to investigate the nuances of women's and men's ways of speaking to clarify how their conversational styles are different ways of reaching the same goals. In later work, I explored the context in which *women's* focus on hierarchy and *men's* on connection is most obvious and most intense: the family. In particular, sisters provide insight into relationships among women that are deeply influenced by competition as well as by connection.

So what does any of this have to do with asking for directions? The route to the answer may not yet be obvious, but read on and I promise to get you there.

"Mine's up to there," one boy declares. "Mine's up to the sky," a second responds, pointing higher.

"Mine's Higher" vs. "We're the Same"

My interest in the linguistic differences between women and men grew from research I conducted early in my career on conversations between speakers of different ethnic and regional backgrounds. These interactions often led to misunderstandings because members of different groups had contrasting assumptions about what should be said and the appropriate way to say it. I sensed, and later showed, a parallel pattern in conversations between women and men—a gender-based culture clash.

I often illustrate this phenomenon using video clips of preschoolers at a day care center. In one scene, four little boys are sitting together, talking about how high they can hit a ball. "Mine's up to there," one small boy declares, raising his arm above his head. "Mine's up to the sky," a second responds, pointing higher. A third boy counters, "Mine's up to heaven!" Then the fourth boy offers: "Mine's all the way up to God." These boys' verbal exchange is obviously a game of hierarchy, as each one's claim tops the preceding one.

I contrast this video clip with another from the same preschool: two little girls are sitting at a small table, drawing. One girl suddenly raises her head, looks at the other, and says (apparently referring to contact lenses), "Did you know that my babysitter, called Amber, has already contacts?" The second girl looks puzzled at first but quickly gathers herself together and announces, with apparent relish, "My mom has already contacts,

FAST FACTS
GENDERSPEAK

1. Men's talk tends to focus on hierarchy—competition for relative power. Women's tends to focus on connection—relative closeness or distance.
2. But all conversations, and all relationships, reflect a combination of hierarchy and connection. The two are not mutually exclusive but inextricably intertwined. All of us aspire to be powerful, and we all want to connect with others. Women's and men's conversational styles are simply different ways of reaching the same goals.
3. The context in which women's focus on hierarchy and men's on connection is most obvious and most intense: the family. In particular, sisters provide insight into relationships among women that are deeply influenced by competition and hierarchy as well as connection.

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and my dad does, too!" The first girl laughs with glee at this echo response, which even mirrors the first girl's odd syntax ("has already" rather than "already has"). After a pause, during which both girls return to drawing, the first one exclaims with delight, "The SAME?!" Being the same is as pleasing to her as topping one another is to the boys.

Although the specific conversational moves—topping versus matching—are different, what these contrasting conversations have in common is that they are rituals: self-evident assumptions about how the conversations should go and what a reasonable remark or response should look like. As with cross-cultural communication, we do not recognize them as rituals until we talk to others who do not share our assumptions.

Girls and women like to match. When they talk, they emphasize their similarities to build intimacy.

MARIA TAGLIENTI-MOLINAR *Getty Images*

Parents tell me that recognizing these as gender-related patterns in their children helps them deal with otherwise baffling behavior. For example, a woman recalled overhearing three little boys—her son and two of his friends—talking in the backseat as she was driving. One boy said, "When we went to Disneyland, we stayed three days." The second boy said, "When we went to Disneyland, we stayed four days." Then her son said, "We're going to move to Disneyland!" She was troubled to hear him utter an obvious untruth. Should she instruct her son not to tell lies? I assured her that the boys knew that her family was not going to move to Disneyland. But her son won that round.

Recognizing these gender-related patterns can help parents deal with baffling behavior in their kids.

A father told me about a similar confusion upon overhearing a conversation between his little girl and her friend. The friend had said, "I have a brother named Benjamin and a brother named Jonathan." His daughter responded, "I have a brother named Benjamin and a brother named Jonathan, too." But she didn't. Her father wondered why she would say such a thing. I explained that she was simply offering a matching experience as a sign of goodwill, to reinforce the friendship.

The contrasting focus on connection versus hierarchy also sheds light on innumerable adult conversations—and frustrations. Say a woman tells another about a personal problem and hears in response, "I know how you feel" or "the same thing happens to me." The resulting "troubles talk" reinforces the connection between them. (Indeed, some women feel they have to dig up problems to tell friends to maintain intimacy.) Because this is not a conversational ritual he is used to, a man may well misread her conversational gambit as a request for help solving the problem. The result is mutual frustration: she blames him for telling her what to do and failing to provide the expected comfort, whereas he thinks he did exactly what she requested and cannot fathom why she would keep talking about a problem if she does not want to do anything about it.

Similar scenarios play out at work, where mutual misinterpretations may have career-altering consequences. For example, if a woman's boss overhears her telling a subordinate, "Could you do me a favor and get me a copy of that report?" he may think she lacks confidence. It appears to him as if she does not feel she has a right to ask her subordinate to do something. But the truth is probably the exact opposite. She knows the subordinate has to do what she asks. Her locution "do me a favor" is simply a way of not flaunting the power she obviously has—and thus saving face for the subordinate. If men often mishear women's ritual indirectness as lacking confidence (or even competence), women often misinterpret *less* indirect rituals as overbearing—and also lacking in confidence. Her thinking goes: he must really lack confidence if he has to throw his weight around like that.

Which takes us back to the woman and man who have different assumptions about asking directions. At the time that I first used this example, before GPS and smartphone technology made it possible to easily access route information on the go, the debate over whether to ask directions regularly took place in cars and often still does. From the woman's point of view, asking directions means making a fleeting connection to a stranger and getting where you are going without losing anything. From the man's perspective, he would be putting himself in a one-down position to a stranger—an uncomfortable experience. He might even believe the effort is counterproductive because a stranger who does not know the way will be similarly motivated by a reluctance to appear one-down and send them on a wild-goose chase. For both reasons, it makes sense to avoid this discomfort and spend 10 minutes—or 20 or 30—finding the way on his own.

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Different Styles, Similar Goals

Despite these differences, women's and men's conversational styles are more alike than they may appear. Although these styles may seem opposite, they can be used for similar purposes. Boys and men are also concerned with connection and girls and women with power, even as they may have different ways of pursuing these goals.

Verbal rituals that focus on connection often involve affirming sameness, as we saw in the little girls' exchange about contact lenses and in the familiar responses: "The same thing happened to me" and "I'm the same way." Yet the contrasting ritual, "That's nothing! Here's what happened to me…," which is typically associated with men—and interpreted as competitive—can also create connection by implying, "You shouldn't feel bad about what happened to you, because what happened to me was worse." In other words, "topping" each other can be another way to commiserate.

Similarly, for girls and women, what appears on the surface to be aimed at connection can also be a way to exert power. Linguist Amy Sheldon of the University of Minnesota has investigated this process by videotaping preschool children playing in same-sex groups of three. She found that both boys and girls pursued their own goals, but whereas the boys she taped were obvious about thwarting another's goals, the girls often did so in ways that appeared to honor the other girls' goals as well. In one example, two girls, Eva and Kelly, were not eager to include the third girl, Tulla, in their play. Instead of telling Tulla outright that she could not play, they included her but assigned her a role that precluded her participation: "You can be the baby brother, but you aren't born yet." Sheldon emphasizes that this is a highly assertive move, even as it maintains the appearance of accommodating Tulla's wish to be part of the game.

In this instance, the children's behavior is not a clear on-or-off application of hierarchy or connection but a blending of both. We could say that Eva and Kelly exercised power to keep Tulla from participating but also honored the connection by assigning her a role.

In contrast, Sheldon observed that when boys played, they tended to insist more overtly on their own goals and even to threaten physical force. For example, when one boy, Nick, wanted to cut a plastic pickle that another boy had, he screamed, "I *have* to cut! I want to cut it! It's mine!" Sheldon stresses, however, that although boys and girls tended to use more of one strategy or another, the difference was not absolute but of degree. Boys did sometimes attempt to compromise, and girls did at times attempt physical force to get their way.

Sheldon's research reminds us that patterns, no matter how real, are never absolute. Again, the asking-directions example is instructive. I didn't realize how common that scenario is because my husband does stop and ask directions, whereas I am the one who says, "I'd rather find it myself on the map." In this respect, he and I are not typical, as many of us are not typical of our genders, cultures, regions or any other group to which we belong.

In a typical casting setup for a family play, an older sister might say, "I'll be the princess; you be the frog."

Older sisters often act dominant to younger sisters, speaking to them in ways more often expected of boys and men.

GETTY IMAGES

Gender differences are a matter of relative *focus* on connection and hierarchy, as we all want to accomplish both goals to some extent. We are always engaged in negotiations over connection and relative power. Eva and Kelly served both goals when they included Tulla—and kept her from participating. Similarly, the boys who verbally competed about how high they could hit a ball also created connection by agreeing on the type of verbal game to play. To understand gender patterns, then, rather than asking, "Does this way of speaking serve hierarchy or connection?" we need to ask, "How does this way of talking reflect the interplay of connection and hierarchy?" And nowhere can this interplay be better explored than in the context that is both universal and fundamental: the family.

Family Ties

Family comes with built-in hierarchy as well as built-in connection. The hierarchy between parents and children is self-evident, but the same is true of siblings. Even though we use the phrases "like sisters" and "like brothers" to describe friendships that are close and equal, actual sibling relationships are defined not only by the connection of shared family but also by the hierarchy of birth order. I have been particularly intrigued by sisters—not only because I have two but, most important, because in sisters we see a relationship between women that is deeply competitive and hierarchical.

In *Having Our Say,* the Delany sisters' 1993 best-selling memoir, Bessie Delany is quoted as saying, "Sadie doesn't approve of me sometimes. She looks at me in that big-sister sort of way." When she said this, Bessie was 101, and Sadie was 103. Elsewhere in the book, Sadie says, "If she lives to 130, I'll just have to live to 132, so I can take care of her." It is as if their relationship was shaped more by the two years separating them than by the century they had lived.

These centenarians' comments reflect dynamics I heard from many of the

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more than 100 women I interviewed about their sisters for my book *You Were Always Mom's Favorite!: Sisters in Conversation Throughout Their Lives,* as well as comments I have heard about brothers: older siblings were often seen as protective but also judgmental. After all, these qualities are two sides of the same coin. "Judgmental" means you see how others can improve themselves and their lives—and tell them. We all often think of ways our friends, relatives and even strangers could do things better. But we usually don't tell them what we think—unless we feel responsible for them. Parents often come across as judgmental to children because they feel it is their right, if not their obligation, to make sure their children's lives go as well as possible, which means letting them know the ways they can improve. Such offers of advice, however, no matter how well-meaning (in other words, focused on connection), are often heard as criticism—and therefore as put-downs. The giver of advice is one-up, superior in knowledge and, by virtue of exercising the right to tell the other what to do, also superior in rank.

Similarly, many older sisters speak to younger siblings with commanding and unambiguous authority—ways of speaking that are more often associated with boys and men. One woman told me when she was small, she and her older sister played a game they called "mop." She was the mop. Her sister would grab her by the feet and drag her around the house, her long hair sweeping the floor like a mop. Several other women recalled their older sisters organizing and directing plays. A typical casting setup was: "I'll be the princess; you be the frog." In my own family, my father overheard me asking my sister, when I was about four and she about six, "Mimi, can I play in your backyard?" Clearly, I did not question the authority that my older sister had assumed in her dealings with me.

At the same time, closeness is the holy grail of sister relationships, as it tends to be for girls and women in other contexts as well. When speaking to women about their sisters, I often heard "I wish we were closer," but never "I wish we weren't so close." Their comments also generally reflected the assumption so common among women that troubles talk is critical for intimacy. Women told me they were deeply hurt to learn that a sister had kept important personal information secret. Whereas a brother (or a father) might say, "He told us when he was ready," sisters (like mothers) often feel, "I thought we were closer than that."

A powerful rivalry often accompanies sisterly ties—but it can take the form of competition for connection. Sisters often feel acutely competitive about who knows what about family members' secrets—or who knows what first. Correspondent Juju Chang, in a segment of the news program *20/20* that was based on my book, explained that she and her three sisters have learned that if one of them has important personal information to impart—news of an engagement or a pregnancy, for example—they must set up a conference call so all three sisters will learn the news at the same time. Otherwise, the sister who is called first will seem to be favored, and the others will feel slighted.

Thus, sisters are often very competitive, and hierarchy is built into their relationship by virtue of birth order. And brothers are often very close and have connection built into their relationship by virtue of shared family. Sisters and brothers tend to vie, however, for dominance in different arenas. Whereas sisters may compete about who knows more personal information about family members, brothers may compete about who knows more facts about impersonal information such as computers or history.

Family relationships make clear that closeness is not opposite or even distinguishable from hierarchy and competition. Indeed, one reason that older sisters feel so comfortable bossing younger ones around and giving them advice is precisely because there is a strong connection between them. In addition, the deep love between older and younger siblings, like that between parents and children, results in part from the acts of caretaking and the experience of being taken care of that these roles entail.

Sisters may compete about who knows more personal information. Brothers may compete about who knows more facts.

Listening in on conversations among family members reveals a unique blend of authority and intimacy in talk among women as well as among men. It highlights the ways in which gendered conversational patterns can be different routes to the same goal: finding the right balance of closeness and distance while simultaneously negotiating relative power. M

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Can women and men be friends? Attraction plays a significant role in opposite-sex friendship, but that doesn't make the bond any less beneficial

"JUST FRIENDS"

BY Carlin Flora

ILLUSTRATIONS BY Brown Bird Design

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KATE AND DAN MET ON THE JOB IN BOSTON, WHEN THEY WERE IN THEIR EARLY 20S.

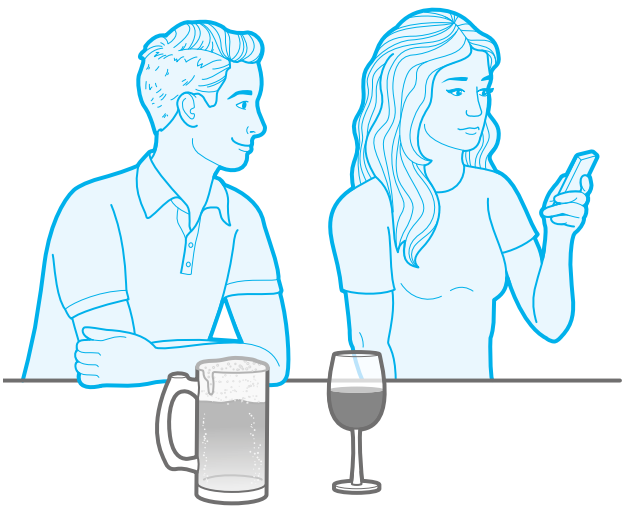
He thought she was attractive; she thought he was an arrogant jerk. At a work party, it came out that both had lost a parent in recent years, and a mutual feeling of "you must really get me" washed over them. A few years later, when they both found themselves in New York and single, the friendship ramped way up, into multiple-phone-calls-per-day, soul-baring, belly-laughing territory.

It is that feeling that someone truly understands us that lends friendship its power to ward off existential loneliness. Kate and Dan share it, yet their brand of friendship is often seen as suspect—as less than pure and true. Friendships between people who could conceivably date come with built-in suspense for onlookers: Will they get together, or won't they?

For philosophers and scientists alike, friendship has proved as difficult to pin down as love. And don't we, after all, love our close friends? Ancient Greek philosopher Aristotle and French essayist Michel de Montaigne in the 16th century felt that true friendship could exist only between virtuous men—holding up a high yet subjective bar that also happened to avoid women altogether. Plato, who lent his name to the term "platonic relationship" (or "platonic love"), described love as a window on true beauty, best kept free of venereal pursuits. Contemporary usage equates platonic relationships with amity rather than love, yet the origin of the term underscores friendship's multifaceted nature. All friendships begin with a spark of mutual attraction, and sometimes that attraction extends to the physical.

In the scientific literature, many scholars have settled on a definition for friendship that was coined by psychologist Robert Hays of the University of California, San Francisco. He described the bond as "a voluntary interdependence between two persons over time that is intended to facilitate socioemotional goals of the participants and may involve varying types and degrees of companionship, intimacy, affection and mutual assistance." Depending on those "types and degrees," friendship can look an awful lot like courtship or love. This raises the question: Can heterosexual men and women be just friends, or is there always an inkling of desire?

Almost half of cross-sex friends experience romantic attraction at some point, so the potential for unrequited feelings is high.



FAST FACTS
FRIENDLY ATTRACTION

1. An inkling of romantic or sexual attraction is common between heterosexual opposite-sex friends.
2. Yet the friendship is not necessarily weaker or less legitimate as a result.
3. Opposite-sex friendships offer unique benefits, including insight into how the other gender thinks, and contribute to our mental and physical well-being.

The data suggest that a romantic spark is not uncommon among friends. Yet the truth is that all forms of companionship are complicated. We often shift our behaviors to try to nudge a relationship one way or another. Our actions only sometimes reflect the disinterested care and concern we assume must characterize an ideal friendship. Even so, romantic or sexual attraction between two friends can be a bonus—a sign of one's social worth—rather than a flaw.

The Rise of Opposite-Sex Friendship

The question of whether men and women can be friends is relatively new, as is research into the dynamics of cross-sex

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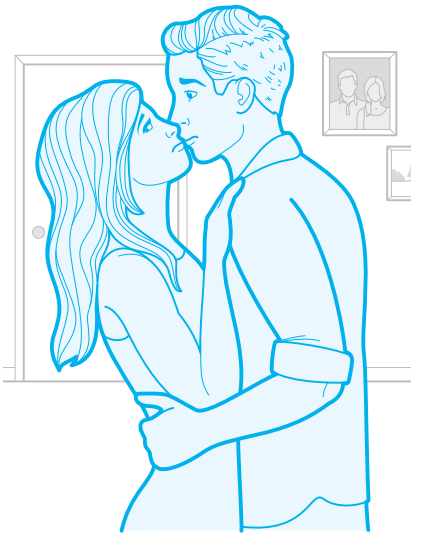
friendships. (Scientific insights into homosexual same-sex friendship are even more scant, so this article will deal primarily with attraction between heterosexual friends of the opposite sex.)

Male-female friendship received its first big break from the feminist movement of the 1960s, which placed men and women on more equal ground in social and work situations. In addition to creating more opportunities for the sexes to interact, the changing social order made men and women more compatible as friends. We overwhelmingly choose friends who resemble us in attitudes and behaviors. It follows that when women and men occupied different and unequal spheres of life, they had less in common and thus were less likely to be close pals.

In the half a century since those social changes set in, opposite-sex friendships have become increasingly common. In 2002, for example, *American Demographics* magazine found that at the time of its survey, 18- to 24-year-olds were nearly four times as likely as people older than 55 to have a best friend of the opposite sex. More recent research also documents the historical novelty of male-female friendships. In a 2012 study psychologist April Bleske-Rechek of the University of Wisconsin–Eau Claire asked college students how many of them had friends of the opposite sex—nearly all did. Compare that with what sociologist Rebecca G. Adams of the University of North Carolina at Greensboro found in 1985, when she asked 70 female senior citizens the same question: fewer than 4 percent of their friends were male.

Certain types of men and women are more likely to have more cross-sex friends. In a 2003 study Heidi Reeder, a communications professor at Boise State University, found that "feminine" men and "masculine" women (as measured by the Bem Sex Role Inventory) had a significantly higher proportion of cross-sex friendships than did "masculine" men and "feminine" women. The inventory is based on traditional sex roles, wherein subjects describing themselves as very "warm" or "sensitive," for example, would score as more "feminine"



An awkward encounter need not doom a friendship. Pals should reaffirm the importance of their bond and tone down flirtatious behavior.

than those describing themselves as "aggressive" and "analytical." The interpretation is simple: whatever our sex, we prefer friends who are just like us.

Justified Doubt of "Just Friends"

With the data clearly indicating that male-female friendship is thriving, perhaps it is time to abandon the old trope that men and women can't be "just friends." Yet the idea has persisted for the simple reason that attraction can cause boundaries to blur. Consider, for example, one rare high-profile opposite-sex friendship from the late 1940s, when the young, religious and Southern Flannery O'Connor met the older, Waspy Robert Lowell at a retreat in upstate New York. Lowell brought O'Connor around to literary parties in Manhattan, with his fiancée also in tow. As O'Connor reportedly once wrote to a friend about Lowell, "I feel almost too much about him to be able to get to the heart of it.... He is one of the people I love."

Psychological research has also documented the ambiguity of many cross-sex friendships. In 2000 psychologist Walid Afifi, then at Pennsylvania State University, surveyed 315 college students and found that approximately half had engaged in sexual activity with an otherwise platonic friend. In a 2012 study Bleske-Rechek and her colleagues asked 88 pairs of opposite-sex college-age friends about their friendship. They also sent questionnaires probing the pros and cons of opposite-sex friendships to 107 people between the ages of 18 and 23 and to 322 adults aged 27 to 55. In general, the men reported feeling slightly more attracted to their female friends than vice versa. Across age groups, participants described the friendships as beneficial overall, although they—and women in particular—tended to consider attraction a cost. For young women and for both sexes in the sample of older subjects, more attraction to their closest friend was associated with feeling less satisfied with their romantic partner. Widespread press coverage trumpeted the implication that men and women cannot be platonic, even if they are not having sex. Yet it is important to note that friendships persisted *in spite of* romantic or sexual attraction—quite the opposite conclusion.

Attraction is the basis of all friendship, and the carnal variety is common but not ubiquitous. Reeder analyzed hundreds of interview transcripts of people reflecting on their closest friend of the other gender and identified four types of attraction among the individuals. Almost all respondents reported feeling "friend-

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ship attraction," that emotional resonance that Dan and Kate experienced once they shared their family histories. Only 14 percent reported "current romantic attraction," defined as the desire to become a couple, although almost half said they had felt it earlier in the friendship. One third felt "subjective physical/sexual attraction," which is a physical urge without a yearning for a serious partnership, and just more than 50 percent reported "objective physical/sexual attraction," meaning they could see why others found their friend attractive even if they were not thus charmed. In short, the odds are pretty good that an opposite-sex friend did, or does, feel some pull toward the prurient.

The Myth of Pure Friendship

With attraction abundant, the question becomes: So what? Skeptics of male-female friendship argue that if one person in the pair wants romance, the friendship is not truly platonic. With emotional skullduggery afoot, a pal's trustworthiness and dependability are thrown into question. Yet this argument oversimplifies the nature of friendship.

First, friends regularly factor into mating goals. Peers can introduce us to a potential partner, help evaluate who is a good match and instruct us in the social nuances that support romantic overtures. "Evolved mating strategies are operating in the background of any relationship," Bleske-Rechek says. "But that doesn't mean we can't have constructive friendships with people we can count on."

Some might argue that currying favor with an opposite-sex pal in the hope of kindling a physical relationship is not in keeping with the tenets of friendship. Yet this kind of behavior is common among companions. Without even noticing it, people routinely adjust their behavior to manipulate how their nearest and dearest feel about them. You might become more diligent about doing the dishes to maintain a peaceful environment at home. Or you might spend extra time composing a witty e-mail to a same-sex friend because you want to preserve that person's respect and admiration. "The idea that there is 'pure' friendship on one hand and friendship with an ulterior motive on the other is false and silly," Bleske-Rechek says.

Boundaries inevitably shift when a best friend falls in love. To avoid feeling left out, invest more in developing other friendships.

Indeed, the bulk of our friendships are imperfect in one way or another. About half of a person's social network is typically made up of ambivalent ties, according to work published in 2009 by psychologists Julianne Holt-Lunstad of Brigham Young University and Bert Uchino of the University of Utah. These are people we are reluctant to give up but who can be unpredictable or irritating. Such friendships extract a physical toll, as the researchers learned after having 107 study participants wear blood pressure monitors. When the subjects interacted with ambivalent friends, their blood pressure spiked higher than when they were with people whom they flat out did not like. Friendships come in many forms, and only a few of them live up to the ideal of selfless, supportive confidantes.

Dealing with Challenges

The stress and uncertainty that romantic attraction brings to burgeoning friendships are not altogether different from the stress and uncertainty of any developing relationship, points out Geoffrey Greif, a professor of social work at the University of Maryland. "When you're beginning a same-sex friendship, you have to evaluate: 'How am I going to pursue him? If I invite him to watch the Super Bowl and he says no, do I invite him to a movie some other time?' You're always trying to gauge the other person's interest." As to whether or not one should confess a desire for a romantic relationship with a friend, Greif recommends asking yourself if you will be unhappy a few years down the road should the person settle down with someone else.

To study the repercussions of such a baring of the soul, Reeder looked at the aftermath of friends' bold (but unsuccessful) disclosures of their secret passion. In friendships that survived the awkward conversation, both people tended to reaffirm the importance of their bond, acknowledge that the disclosure was acceptable, tone down any flirtatious behavior or innuendo, and resume their earlier contact patterns. The friend who demurred also acknowledged that the confessor's assumptions about the relationship's potential were justified, after which the confessor dropped the topic. Down the line, both pals openly discussed new prospective romantic partners.

In doomed friendships, the confessor complained and acted bothered when the friend did not agree to shift into romance and avoided contact with the object of their affection. The rejecter dangled false hope ("It's just that I'm with someone else right now") and told other friends about the episode.

After Dan moved to New York, "we were hanging out as friends, and Dan was being flirtatious. He's so charming and funny," Kate recalls. One night Dan went to Kate's apartment for dinner, a romantic setting that brought the question of dating into stark relief. "One little kiss happened," Dan recalls, "and it felt like kissing my sister."

"Part of the awkwardness," Kate says, "was [me thinking] 'I like this guy

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so much.' We are never going to work out romantically—I can't even explain why—but we are destined to be really good friends. I felt so certain about that."

Later, when Dan got married, the two friends learned to adjust to new boundaries. They pulled back on the number of hours they spent on the phone together, and Kate realized she could not lean on him as much for emotional support. "I started to develop some of my other friendships more," she says. Dan's wife took on the role of his primary confidante, and he became more mindful that his outings with friends not eclipse their time together at home. As for Kate's potential threat as an attractive female: "My wife never expressed discomfort," he notes, "because I think she realized, just from being around us, that it was platonic and that it was a nourishing friendship. But I had to adjust to the change, too."

Friends with Many Benefits

The good news is that most cross-sex friendships survive the pangs of romantic tension. Potential awkwardness aside, having a friend who is attracted to you can be beneficial. "Anytime someone expresses interest in you," Reeder says, "they are affirming your worth in the social world." She speculates that partners in a stagnant romantic relationship might feel empowered by the admiration of an opposite-sex friend.

Indeed, these friendships offer a few unique benefits beyond the standard assets of having a buddy. Men and women both report turning to opposite-sex pals to glean insights into how the other gender thinks. Dan, for example, describes how he often hears Kate's voice in his head as he contemplates relationship issues and dealings with women in general: "It's a necessary counterbalance to my male brain."

Advice regarding a love interest might be the key dividend in one kind of cross-sex friendship: those between gay men and straight women. A 2013 study found that straight women are more likely to heed mating counsel from a gay man than from other sources, and gay men are likewise more inclined to trust advice from straight women than from straight men or lesbians. Unlike other alliances, friends who cross both sex and sexual orientation neither compete for mates nor weather the turbulence of unrequited desire. As a result, this bond has the potential to foster more trust than other ties, especially when it comes to unbiased dating insights.

More generally, strong friendships of any stripe are a tremendous boon to physical and mental health. To wit: Holt-Lunstad conducted a meta-analysis (a quantitative review of numerous studies) and concluded that having few friends is the mortality risk equivalent of smoking 15 cigarettes a day. People with a close friend at work are more productive and more innovative and have more fun than those without one. Couples, too, benefit when both partners have opposite-sex friends. Those who have a larger percentage of shared friends, as opposed to individual friends, tend to have happier and longer-lasting relationships. Strong social connections, in fact, are the biggest predictor of happiness in general.

No matter the gender, friendships promote health and improve the quality of romantic relationships.

Given the importance of social support to a healthy mind and body, it is unwise to kick half of the population out of your pool of potential friends. "Kate has made me less selfish," Dan says. "Between us there's a sense of acceptance of the other person's neuroses, flaws—and even enjoyment of them. I take great comfort in a relationship that has stability even though it ebbs and flows in intensity."

"Dan has influenced me—his work ethic has been inspiring, how seriously he takes his work. And I thrive on his sense of humor," Kate says. "He's a friend I can completely trust. What a rare feeling that is, to be able to say anything to someone, without feeling censored." Their decade-plus friendship, she says, "feels like one ongoing conversation."

Kate and Dan have reached the highest levels of friendship, where life's great rewards—love, pleasure, and the ability to grow and learn—abound. They exemplify Aristotle's view on the best kind of friends. As described by philosopher Massimo Pigliucci of the City University of New York in his book *Answers for Aristotle,* such friends "hold a mirror up to each other; through that mirror they can see each other in ways that would not otherwise be accessible to them." Whether the person holding the mirror is male or female hardly matters. M

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THE SEXUAL BRAIN

5/5

COUPLING

BY Eli J. Finkel, Paul W. Eastwick, Benjamin R. Karney, Harry T. Reis and Susan Sprecher

DATING IN A DIGITAL

Understanding the science of online dating can turn a frustrating experience into a fruitful mission

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With online dating, singles can now search for romance whenever they want, including while cozy in their pajamas.

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ROMANTIC RELATIONSHIPS CAN BEGIN ANYWHERE.

When Cupid's arrow strikes, you might be at church or at school, playing chess or softball, flirting with a friend of a friend at a party or minding your own business on a train. Sometimes, however, Cupid goes on vacation, or takes a long nap, or kicks back for a marathon of Lifetime original movies. Instead of waiting for the capricious arrow slinger to get back to work, many people today use online dating sites and apps to assert some control over their romantic lives.

For millennia, cultures have developed practices to fulfill the evolutionary imperatives of mating and reproduction. In the Western world today, individuals are largely expected to identify romantic partners on their own, a process that can consume significant time, effort and emotional energy—and that provides no guarantees. The ability to hunt for dates online offers singles a modicum of control over a seemingly random process and grants them access to hundreds, potentially thousands, of eligible mates. The appeal of this unprecedented opportunity to pursue romance beyond one's social circles and neighborhood haunts has helped launch a multibillion-dollar industry.

Traditional online dating sites work like this: users create profiles describing themselves and then search a Web site for possible romantic partners according to various criteria—within their geographical proximity, for example, or perhaps by educational levels, age range or religion. Some sites attempt to play the role of matchmaker and use proprietary algorithms to suggest pairings between users, whereas other sites give their customers free rein. By 2009, a mere 15 years after Netscape released the first major Web browser, one quarter of heterosexual couples and two thirds of same-sex couples were meeting online.

Rather than dabbing on perfume or cologne and preparing for a night on the town, singles using online dating services can peruse potential partners while drinking their morning cup of coffee, during meetings at work or when lying in bed for 10 minutes before nodding off. This is not your grandparents' dating landscape.

Not all the changes are constructive. Critical assumptions lurk in the mechanisms of online dating. One supposition is that people are good judges of which qualities described in an online profile will appeal to them in person. A second premise is that comparing multiple potential partners side by side is an effective way to evaluate compatibility. A third is that two people's questionnaire responses can, when paired with fancy math, reveal their underlying romantic compatibility. Several lines of scientific work suggest that none of these hunches is true.

This disconnect between the assumptions underlying online dating, which are reinforced by the services' overheated claims, and the realities of human psychology often yields dissatisfaction. Avid users may invest tens of hours every month in browsing profiles and only rarely arrange a date. They may contact dozens of potential partners and hear back from only a small fraction of them. They may set up dates with individuals who seem perfect "on paper" only to learn on the first date that as a pair they have no chemistry.

For online daters, what follows is a survival guide. For others, a look at today's dating methods offers revealing insights into the human psyche.

Set Limits for Yourself

Online dating is almost nothing like a typical night out on the prowl. At a bar, a man might size up the room before letting his gaze settle on the thirtysomething brunette with the welcoming smile and the sparkling eyes. If he approached her and managed to strike up a conversation, he could take in her nonverbal cues–such as her gestures, posture and gaze—as he tried to make her laugh.

If he were instead reading her profile on an online dating site, he would have learned that she plays board games on the weekends, works as a pastry chef and loves horror movies. A connois-

FAST FACTS
MINDFUL MATCHMAKING

1. Online dating, a multibillion-dollar industry, offers singles an unparalleled opportunity to meet and arrange dates with people outside their own social circles.
2. Often these services encourage users to rely on decision-making styles that are not well suited to the development of successful relationships.
3. Awareness of the obstacles in this psychological terrain can help online daters make the most of these services.

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seur of art-house films still tormented by a childhood viewing of *A Nightmare on Elm Street*, he might have already clicked past her.

With the carrot of romance always dangling a mouse click away, the temptation to scan—and cavalierly dismiss—dozens of profiles is strong. We all value having options, but too many can undermine our ability to make good decisions. In one experiment, people who viewed 20, rather than four, online dating profiles were more prone to misremembering the information in those profiles. In a second experiment, as the number of profiles grew from four to 24 to 64, users switched from time-consuming choice strategies that attend to and integrate multiple cues to lazier strategies that superficially examine few elements and do not combine them effectively.

These cognitive biases are hard but not impossible to counteract. Remain aware of how many profiles you have scanned in a single browsing session and impose a time limit. View profiles in manageable clusters and consider reaching out to, say, one out of every 20 users. Keep in mind that behind the profile is a flesh-and-blood human.

Mobile dating sites help get people face-to-face more efficiently than traditional online dating sites do.

Monitor Your Mind-set

People tend to evaluate romantic prospects differently depending on how they encounter them. Many studies in nonromantic domains have demonstrated that people are inclined to prioritize different qualities when they compare multiple options side by side—referred to as a joint evaluation mind-set—than when they size up one specific possibility in isolation, known as a separate evaluation mind-set.

A study of incoming college freshmen explored this idea in the context of dormitory assignments. Before learning which one of 12 dormitories they would be randomly assigned to, the students anticipated that physical features, such as the build-

Online daters may be tempted to scan dozens of profiles at a time, but viewing a smaller cluster makes for a more thoughtful evaluation.

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ing's location and the size of its rooms, would strongly influence their future happiness. None of these attributes ultimately predicted their well-being. Instead experiential qualities—such as the relationship with one's roommate and the social atmosphere of the dormitory—trounced any of the lodgings' physical characteristics.

One explanation for this discrepancy between expectation and reality is that the freshmen were in a joint evaluation mind-set when making the predictions and in a separate evaluation mind-set when living in the assigned dorm. Before moving in, they were more sensitive to unimportant physical variations simply because those differences were easy to judge as they compared and contrasted the 12 dormitories. Browsing profiles of potential romantic partners is also likely to trigger a joint evaluation mind-set and cause users to overvalue qualities that are easy to assess but unlikely to determine compatibility. Indeed, traditional online dating profiles are chockfull of details that tend to be largely unrelated to the hard-to-discern, experiential characteristics that promote relationship well-being. Levels of education or physical attractiveness, for example, can easily be assessed through a profile, whereas rapport and sexual chemistry can only be evaluated face-to-face.

Engaging in joint evaluation can also strengthen so-called assessment mind-sets and undermine locomotion mind-sets. When in an assessment mind-set, a person critically evaluates a specific option against available alternatives. When in a locomotion mindset, in contrast, a person focuses on a particular selection, such as a desirable mate, and pursues it vigorously. To be sure, all dating involves some degree of assessment. The side-by-side evaluation of countless online dating profiles, however, seems to invoke an especially strong assessment mind-set regarding the general pool and an especially weak locomotion mind-set with respect to any single person. We recommend taking a moment to imagine what it might be like to talk to the person behind the profile face-to-face. Mentally simulating a social interaction is likely to make you less critical and more motivated to consider possible ways you might be compatible.

Appraising numerous dating profiles side by side can easily overwhelm online daters. Imposing a time limit can help.

Cast a Wide Net

Studies suggest that online daters typically aim too high. They contact the most objectively desirable individuals—those whose profiles make them look the sexiest or the wealthiest, for example—at massively higher rates than others. In a real-world dating scenario, attendees at a party would not all mob one attractive individual, but that is essentially what happens online because these daters cannot see how much attention a person is already receiving. These desirable people are the least likely to respond to e-mails, and both the deluged daters and their pursuers become frustrated as a result.

Part of the problem appears to stem from the attitudes that daters adopt, intentionally or not, when on these sites. In one 2010 study Rebecca Heino of Georgetown University and her colleagues described online dating as "relationshopping." The shopping metaphor is apt. Much like hunting for size 8 leather shoes on Zappos.com, online daters seek partners by searching through profiles using attributes such as income and hair color, as opposed to arguably more important factors, such as a sense of humor or rapport. One online dater illustrated the shopping mentality as follows: "You know, 'I'll take her, her, her'—like out of a catalog." A second online dater agreed: "I can pick and choose; I can choose what size I want, it's like buying a car, what options am I looking for."

This checklist mentality underscores our lack of self-knowledge when it comes to romance. In one experiment, research participants who evaluated an online dater's written profile expressed more attraction toward a person whose description was rigged to match their own idiosyncratic preferences. After a brief live interaction, however, the participants' stated preferences no longer predicted romantic interest. These experiments reveal that the online profile descriptions that are especially appealing or unappealing to us are poor indicators of what we are likely to find attractive in real life.

Rather than getting hung up on figuring out who has the most appealing profile, get past profile browsing as soon as you can and do not expect too much from that process in the first place. Stay open-minded to discovering the person you are meeting and whom you might end up falling for—and who might love you back.

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Deprived of the social cues that modulate dating behavior in face-to-face interactions, online daters tend to contact the most objectively desirable people at much higher rates than other individuals.

Communicate with Care

Traditional online dating sites include easy methods, such as anonymized e-mail and online chat functions, for users to communicate with prospective dates. In fact, dating hopefuls must converse through one of these methods before switching to a personal e-mail account or messaging each other through social media. If these interactions go well, the romance seekers typically agree to meet in person in short order.

Unfortunately, many potential love connections never get started. One reason is that not all profiles on a site represent paying or active users. (When Ashley Madison, a service that facilitates extramarital affairs, suffered a data breach in 2015, consumers of the mainstream media learned that only a tiny fraction of the female profiles were actually linked to real women.) In addition, responses to initial overtures can be few and far between. In one study, men replied to one out of four messages they received through a dating site, and women replied to one in six. More promisingly, this study found no evidence that eager responses were a turnoff; the faster the reply, the more likely that reciprocal communication continued. If you sense a spark, don't play hard to get.

Singles at a party would not all mob one attractive person, but that is essentially what happens online.

At this stage, the incipient relationship is still fragile. Do not wait too long to set up a date. Many pairings that start communicating outside the dating site's messaging systems meet face-to-face within a month, frequently within a week. Doing so is wise, as research shows that although a small amount of e-mailing or chatting online can increase attraction when two daters meet, too much of it tends to instill overly specific expectations, which can complicate the initial meeting.

Ultimately there is *something* that people must assess face-to-face before a romantic relationship can begin. Scholars are still working to identify exactly what that something is, but it appears to reside at the intersection of behavioral synchrony, chemistry and gut-level evaluations. Some emotional reactions could even be based on sensory experiences, such as smell, that cannot be gleaned through a digital screen. Meeting in person also serves as an important reality check before intimacy progresses: it is a whole lot easier to lie in a profile or an e-mail than face-to-face.

Don't Bet on Matching Algorithms

Several high-profile dating sites promise to match users with an especially compatible partner identified via a proprietary matching algorithm. Unfortunately, these companies have failed to provide any convincing evidence supporting their claims. We encourage you to consider this limitation before investing the sometimes considerable resources required to join such services and before allowing a matchmaking algorithm to eliminate partners from your potential dating pool. For better or worse, dating-site algorithms can probably discern which people have an increased risk of experiencing relationship problems by assessing individual differences such as neuroticism or a history of substance abuse. Some people are indeed better at sustaining intimacy than others. By assessing these types of characteristics, online dating sites can potentially screen out the relationally challenged more efficiently and effectively than an

MORE SCIENCE See the *Psychological Science in the Public Interest* article, "Online Dating: A Critical Analysis from the Perspective of Psychological Science," on which this story for *Scientific American Mind* is based, at the Association for Psychological Science's Web site: **www.psychologicalscience.org**

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individual dater can. This is a potentially useful service, as long as you are not one of the unlucky folks who gets eliminated.

This filtering service, however, yields far less than what algorithm-based matching sites typically promise. They pledge to identify potential mates who are particularly compatible with you—your soulmate, even—a claim that is every bit as dubious as it sounds. The problem is not simply that no matching site has mustered any compelling evidence that its algorithm is effective. A deeper problem is that decades of research suggest that the most important determinants of a relationship's fate emerge only after the pair have met—factors such as the way the partners navigate interpersonal conflict, respond to unpredictable events together or share good news with each other. Because matching sites have demonstrated insufficient ambition or creativity, their approaches are based solely on qualities of individuals that can be known prior to meeting in person. As a result, these algorithms are poorly equipped to predict whether strangers on a date will linger over dessert or quickly request the check. Discerning whether two people will live happily ever after is even further out of reach.

Brief interactions online can boost attraction, but too much can lead to overly specific expectations.

In recent years we have repeatedly thrown down the gauntlet, challenging these algorithm-based matching sites to put up or shut up—either to provide evidence in support of their claims or to stop making them. It is obvious to any trained scientist how to test whether a given algorithm actually works: online daters would be randomly assigned to one of four experimental conditions. In the wait-list control group, participants would experience no intervention. A placebo-control group would consist of subjects who believe they are being matched by the site's algorithm but are actually matched at random. Daters in a relationship-aptitude control group would be paired randomly with people who tend to be good at relationships in general and are not, say, especially neurotic. Last, individuals in an algorithm group would be paired with people selected by the site's matching technology.

If the members of the fourth group experienced romantic outcomes superior to those of the participants in the other three groups, then we would have credible evidence that the algorithm is effective. Given that we have repeatedly spelled out

The information that best predicts a relationship's success, such as rapport and compatible senses of humor, can only be gleaned in person.

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how matching sites could demonstrate their value, it seems suspicious than no site has done so—or allowed independent scholars to perform the study on its behalf. Until matching sites that claim to use science actually conduct adequate experiments, online daters should think twice before paying a premium for such services.

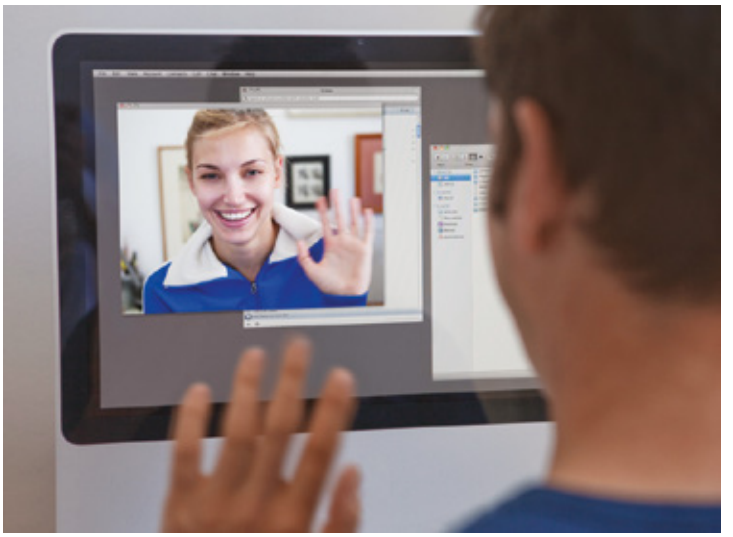
Ride the Tinder Wave

Traditional online dating sites are alive and well, but a smartphone-based alternative called mobile dating has recently gone mainstream. Mobile dating sites, which leverage GPS technology to help singles locate potential partners in their immediate proximity, adopt a minimalist user interface that helps get people face-to-face much more efficiently than traditional online dating sites do. Tinder, which took the dating world by storm in 2014 and remains the dominant mobile dating site today, employs a simple procedure in which users view photographs of potential partners, swiping right if the partner appeals to them and swiping left if not. If two individuals swipe right on each other's image, they can begin texting through the app, perhaps even setting up a first date for 10 minutes hence.

Mobile dating sites have both disadvantages and advantages, but the latter outweigh the former. On the downside, making initial romantic decisions on mobile dating sites tends to be even more appearance-based than other forms of dating, including traditional online dating sites. On the upside, mobile dating circumvents three major failings of traditional online dating sites: the emphasis on studying profiles to assess compatibility, the tendency for certain individuals to be deluged with offers from people they have not expressed interest in, and the false claims about matchmaking algorithms. Mobile dating helps people set up first dates with people they otherwise would not meet—and it does so far more efficiently than traditional online dating sites do.

Know What Works

"Online dating" is a misnomer. What happens online is the meeting. The dating happens at bars or coffee shops or sporting events or state parks—at the same places where people who meet offline go on dates. Once you go on a first date, you can assess your level of attraction to the other person. If there's a spark, you can play it out. Maybe it will be a short-term tryst. Maybe it will be happily ever after. Once you've gotten to the first date, the rest is up to you (at least until you're ready to dip back into the online pool to search for somebody new).



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Although communication through video chat can help acquaint two people, an in-person meeting is the best bet for assessing romantic compatibility.

Some aspects of online dating services are marvelous. Dating sites provide access to potential sources of romance that might otherwise be unavailable to their clients. They can transcend geographical and social-network boundaries to an unprecedented degree. These benefits may be especially powerful for those people who need it the most—including those who are socially anxious, who have recently moved to a new city, or who have demanding schedules that limit opportunities to socialize.

In general, online dating sites present a unique opportunity to bring happiness into the world. The industry is still young, which is probably one reason it has so many flaws. As these services increasingly incorporate the best relationship science, they will continue to evolve and improve. When wielded with skill and rigor, these sites can help millions of lonely hearts find love. **M**

MORE TO EXPLORE

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PERVSPICACITY

A PROVOCATIVE BOOK SURVEYS THE WIDE WORLD OF PASSIONATE PROCLIVITIES

When I met with psychologist and author Jesse Bering in October 2013, I asked him when he intended to write a book that I could read on the subway without the cover bringing me unwanted attention. The title of Bering's 2012 book—*Why Is the Penis Shaped Like That?*—was bad enough, even though it offered up fascinating insights into the evolution of anatomy. But that was nothing compared with the pitchforks-and-torches looks from people who spied me perusing his more recent work, *Perv: The Sexual Deviant in All of Us*. Bering's response to my entreaty was, "I'm working on it." I'll believe it when I see *it*. [*Editors' note: Scientific American/Farrar, Straus and Giroux publishes Bering's books.*]

In addition to the eye-catching verbiage, the cover of *Perv* features a picture of a sheep. "That was the publisher's idea," Bering told me. "I went along with it, obviously. I think it's kind of like a Rorschach test in terms of what people see with the sheep on the cover. It's got multiple meanings. I do talk about zoophilia in the book, so it has that much more explicit meaning of bestiality, of course. But also, the lamb represents innocence. A lot of people see that."

I confessed that the connection to innocence never occurred to me. "Well, that says a lot about you, actually," he joked. At least, I assume he was joking. I mean, I like a nice wool jacket, but that's as far as it goes.

Bering was kind enough to dedicate *Perv* to me. And to you. And, well, to any reader brave enough to crack the binding. (Still talking about the book here.) The dedication reads, "For you, you pervert, you." That notion would have been even more accurate in 1948, when Alfred Kinsey published *Sexual Behavior in the Human Male*. In *Perv,* Bering notes that Kinsey's research revealed that "75 percent of adult American males were technically 'sex deviants' according to the mental health criteria at the time."

If the vast majority of guys were thus abnormal, what's normal? We all have our little peccadilloes, which may include things that sound like various parts of the word "peccadilloes." "One person's lewd exorbitance," Bering writes, "is another's slow Monday morning." Indeed, the book is tumescent with the expected exorbitances: foot fetishists, amputee adorers, Lycra lovers and S&Mers (who aren't just fans of my initials) will all find themselves dissected (nonnecrophilously) within *Perv*'s pages.

The book's surprises, to my innocent self anyway, come in discussions of people who develop strong attachments to nonliving things. You might think you love your old Dodge Ram (no relation to the sheep on the cover), but what you and your pickup share is a pale imitation of the true, deep and abiding intimacy experienced by objectophiles.

Don't assume that the objectophile's love for that new iPhone feels sadly but necessarily unrequited, either. Bering notes that such people may have a neurological condition called object personification synesthesia, "which causes them to perceive personalities and emotions, including sexual desires, in inanimate objects." Before you borrow that smartphone, you might want to ask where it's been.

Objectophilia extends beyond mere consumer products. Bering tells the story of a Swedish woman who in 1979 married the Berlin Wall. "Today she considers herself a widow," Bering writes. Although I bet she'd admit that trying to have a meaningful conversation with her beloved was like talking to a husband.

Then there's the case of the American woman who goes by the name Erika Eiffel because she (to her satisfaction) consummated a relationship with the towering Paris landmark. It's her second structural situation: she was previously involved with the Golden Gate Bridge. That affair no doubt took a toll. M

ILLUSTRATION BY MATT COLLINS

BY **STEVE MIRSKY**
Steve Mirsky has been writing *Scientific American*'s humor column, Anti Gravity, for 20 years. He also hosts the *Scientific American* podcast Science Talk.

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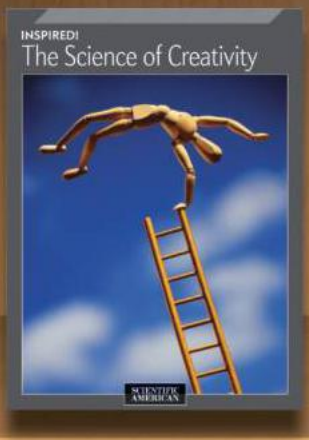

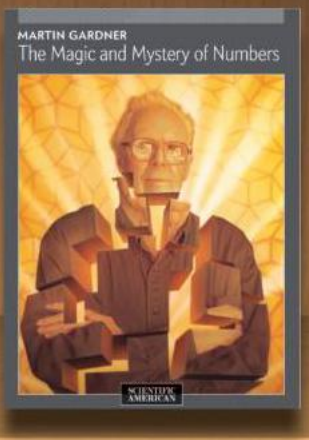

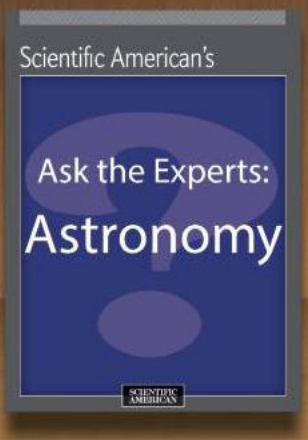

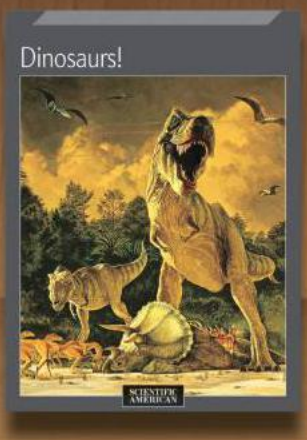

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